Printed on Thin Paper for Foreign Circulation.

Engineering Library

MAY 20 1922

# The Engineer.

Established 1856.

Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 33, NORFOLK ST., STRAND, LONDON, W.C. 2.

VOL. CXXXIII.—No. 3462] LONDON: FRIDAY EVENING, MAY 5, 1922 [PRICE {WITH SUPPLEMENT} ONE SHILLING BY INLAND POST 1s. 3d.

## PUBLIC NOTICES

The High Commissioner for India is prepared to receive TENDERS for the SUPPLY of :—
PLATES, MILD STEEL.
PINS, KEEP, SPLIT, AND SCREWS, IRON.
Forms of Tender may be obtained from the Director-General, India Store Department, Belvedere-road, Lambeth, S.E. 1, and Tenders are to be delivered at that office not later than Two o'clock p.m. on Friday, the 26th May, 1922.
T. RYAN,
Director-General.
8096

G. R.

BY DIRECTION OF THE DISPOSAL BOARD.
SOUTHAMPTON.
THE VALUABLE
FREEHOLD
ROLLING MILLS,
Known as
GOVERNMENT ROLLING MILLS,
SOUTHAMPTON,
Including certain PLANT
To be Sold (by Private Treaty).

SITUATION.—The property is situate in Weston-grove, close to the railway, tram and ferry, and adjacent to the River Itchen, in which is situate a jetty connected with the Factory.
AREA OF LAND.—About 32 acres.
BUILDINGS.—The main buildings are of substantial brick construction with Belfast truss roofs, and the property is equipped with the most modern Mills and auxiliary Plant and Machinery.
The principal buildings comprise :—

| | Approx. floor area, ft. super. |
|---|---|
| Rolling Mills | 124,200 |
| Capping Shop | 74,800 |
| Foundry | 74,800 |
| Warehouse No. 1 | 19,900 |
| Warehouse No. 2 | 11,200 |
| Warehouse No. 3 | 12,200 |
| Warehouse No. 4 | 19,900 |

TOTAL FLOOR AREA OF MILL ABOUT 337,200 FEET SUPER.

SIDINGS.—Private sidings are laid and arrangements might be made with the railway company for a connection.
POWER AND LIGHTING.—Electric, generated by plant on site.
HEATING.—High and low-pressure steam and hot air systems.
WATER.—From public main and stream.
Further particulars, plan and permits to view may be obtained on application to the CHIEF VALUER, Lands and Factories Section, Disposal Board, Room 279, Caxton House, Tothill-street, Westminster, S.W. 1. 8083

SALE BY TENDER.

G. R.

BOARD OF TRADE.
BY ORDER OF CONTROLLER, TIMBER DISPOSAL DEPARTMENT.
AERIAL ROPEWAY,
KINGSLAND STATION, HEREFORD.
To be Sold by Private Tender,
the AERIAL ROPEWAY at KINGSLAND STATION, as and where standing.
TOTAL LENGTH ABOUT 9¼ MILES.
Trestles or standards, 63 in number, from 16ft. to 80ft. in height, built of angle iron in sections of 6ft. lengths by 2ft. 3in. square. The ropeway is worked by a 12 H.P. PORTABLE ENGINE, which may be included in the offer or left out.
All the spare sections or parts of the ropeway lying at Kingsland unloading station or at the loading station are included.
Offers for above ropeway, with or without engine, will be received by ACTING CONTROLLER, 49, Wellington-street, London, W.C. 2, up to and including May 25th, 1922.
The highest or any offer will not necessarily be accepted. 8105

Borough Polytechnic Institute,
BOROUGH-ROAD, LONDON, S.E. 1.
The Governors will REQUIRE in September next a fully qualified TEACHER of ACETYLENE WELDING (Theoretical and Practical), for two or more evenings a week. Particulars of the appointment may be obtained by sending stamped addressed foolscap envelope to the undersigned.
C. T. MILLIS,
Principal.
8116

University College of Swansea.
APPLICATIONS are INVITED for the POST of LECTURER in CIVIL ENGINEERING. Salary £500 per annum. The appointment will date from October 1, 1922.
Further particulars may be obtained from the undersigned, by whom applications must be received on or before May 15, 1922.
EDWIN DREW,
Registrar.
Singleton Park, Swansea,
April, 1922. 7989

Borough of Newark.
SEWERAGE WORKS.
TO IRONFOUNDERS.
The Corporation is prepared to receive TENDERS direct from Ironfounders for the SUPPLY and DELIVERY at Newark, Notts, of about 800 TONS of CAST IRON PIPES and SPECIAL CASTINGS.
The pipes and special castings will range from 6in. to 30in. diameter, the principal sizes being 18in., 21in. 24in., and 30in.
Quantities may be obtained from the offices of the Engineers, Messrs. W. H. Radford and Son, Albion Chambers, King-street, Nottingham, on deposit of Two Guineas (cheque), which sum will be returned on receipt of a bona fide Tender and the return of the quantities.
The lowest or any Tender will not necessarily be accepted.
Sealed Tenders to be sent to the undersigned on or before May 17th, 1922, endorsed "New Ironwork."
By Order,
H. TALLENTS,
Town Clerk.
Town Clerk's Office, Newark,
April 20th, 1922. 8068

## The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

April Engineering Notes.
The James Forrest Lecture.
Steam Turbine Reliability.
Carels Factory at Ghent. (With a Two-Page Supplement)
The Action of Cutting Tools.
Railway Congress at Rome.
Speed Reduction Gearing.
Blast Furnace Practice.

## PUBLIC NOTICES

Great North of Scotland Railway Company.
CONTRACTS FOR STORES.
The Directors of the Great North of Scotland Railway Company are prepared to receive TENDERS for the SUPPLY of the undermentioned STORES for six months from 1st July, 1922 :—

| | No. of Form. | | No. of Form. |
|---|---|---|---|
| Brooms, Brushes, &c. | 1 | Glass (Plate and Sheet), Lamp Chimneys, &c. | 14 |
| Canvas, Rope, Flax and Twine | 2 | Handles (Hammer, &c.) and Shunting Poles | 15 |
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Forms of Tenders can be obtained from the Stores Superintendent, 90, Guild-street, Aberdeen, on payment of One Shilling for each form.
Patterns may be inspected at the Stores Depot, Inveruric, between the hours of 10 a.m. and 4 p.m., from Monday, 22nd May, to Saturday, 27th May, inclusive, except on Saturday, 27th, when they will not be on view after Twelve o'clock Noon.
Tenders, endorsed "Tender for Stores," must be lodged with the undersigned not later than 10 a.m. on Tuesday, 30th May next.
The Directors do not bind themselves to accept the lowest or any Tender.
T. S. MACKINTOSH,
Secretary.
Company's Offices,
90, Guild-street, Aberdeen,
28th April, 1922. 8071

Madras and Southern Mahratta Railway Company, Limited.
The Directors are prepared to receive TENDERS for :
(1) 22 BOGIE CARRIAGE UNDERFRAMES (Metre Gauge).
3 UNDERFRAMES for 4-WHEELED CARRIAGES (Metre Gauge).
(2) 110 PAIRS WHEELS and AXLES (Metre Gauge).
(3) 955 TONS STEEL MATERIAL (Plates, Rounds, Flats, &c.),
in accordance with the specifications, which may be seen at the offices of the Company. The charge for each specification is One Guinea, which will not be returned.
Tenders must be sent in, addressed to the SECRETARY, not later than 2 p.m. on Tuesday, 23rd May, 1922, marked "Tender for Bogie Carriage Underframes," or as the case may be.
The Directors do not bind themselves to accept the lowest or any Tender.
Company's Offices :
25, Buckingham Palace-road,
Westminster, S.W. 1,
2nd May, 1922. 8111

The National Foremen's Association of the
ENGINEERING AND ALLIED TRADES.
(Registered under the Trade Union Act.)
An Association specifically formed to look after the Interests of Foremen in their Supervisory Capacity.
All communications to Head Office,
E. W. REID, 98, Belgrave-road,
General Secretary. Victoria, S.W. 1.
8x.

## PUBLIC NOTICES

North-Eastern Railway.—The Directors are prepared to receive TENDERS for the RECONSTRUCTION of the ROADWAY over the High Level Bridge, Newcastle. The work consists of about 350 tons of steel work, 40 tons of cast ironwork, 10,000 c. ft. of timber, and 1800 s. yds. of wood block paving. Plans may be seen and specification, detailed quantities, and form of Tender obtained on personal application at the office of Mr. C. F. Bencraft, Chief Engineer, York, on and after Wednesday, May 3rd, 1922. Sealed Tenders, marked "High Level Bridge," must be received by the Secretary, York, not later than 9 a.m., Wednesday, May 17th, 1922. The Directors do not bind themselves to accept the lowest or any Tender.—R. FRANCIS DUNNELL, Secretary, York, 2nd May, 1922. 8100

Siam State Railways.
NOTICE.
TENDERS are INVITED for SUPPLY of LOCOMOTIVES and TENDERS.
Specifications and drawings may be obtained against payment of £2 from Messrs. C. P. Sandberg, 40, Grosvenor-gardens, London, S.W. 1.
Sealed Tenders, with the inscription "Tender for Supply of Locomotives and Tenders," must be forwarded to the undersigned, at whose office in Bangkok, Siam, they will be received up to 2 p.m. on the 15th September, 1922, at which place and hour the Tenders will be publicly opened and read.
Right is reserved to reject any or all Tenders and to accept any Tender which, in the opinion of the undersigned, is to the best interests of the Siam State Railways.
GENERAL PURACHATRA,
Commissioner-General.
Department of State Railways, Bangkok,
6th March, 1922. 8115

Stepney Borough Council.
ELECTRICITY SUPPLY.
A.—BOILERS AND BOILER-HOUSE ACCESSORIES.
B.—TURBO-ALTERNATORS, CONDENSERS, ACCESSORIES AND SWITCHGEAR.
The Electricity Supply Committee of the Stepney Borough Council invite TENDERS from responsible contractors for the CARRYING OUT of the following WORK at the Council's Limehouse Station, viz. :—
(a) The MANUFACTURE, SUPPLY and ERECTION complete of THREE WATER-TUBE BOILERS, together with CHIMNEYS, ECONOMISERS, and other ACCESSORIES.
(b) The MANUFACTURE, SUPPLY and ERECTION of TWO 10,000 K.W. TURBO-ALTERNATORS, with CONDENSERS, ACCESSORIES, and SWITCHGEAR.
Copies of the general conditions, specifications, forms of Tender and drawings may be obtained from Mr. Wm. C. P. Tapper, M.I.E.E., Borough Electrical Engineer and Manager, No. 27, Osborn-street, Whitechapel, E. 1, upon receipt of a deposit of Five Guineas for each section. Deposits will be returned to bona fide tenderers after the Tenders have been considered by the Council. Additional copies, with drawings, may be obtained upon payment of the sum of One Guinea, which will not be returned. Copies of the specifications and drawings may be inspected at the above-mentioned address by appointment.
Tenders, on the form supplied, endorsed "Tender for Section "A" or Section "B," as the case may be, must be delivered, signed, sealed and addressed to the Chairman of the Electricity Supply Committee at No. 27, Osborn-street, Whitechapel, E. 1, not later than June 8th, 1922.
The Council do not bind themselves to accept the lowest or any Tender, and the acceptance of any Tender is subject to the sanction of the Electricity Commissioners to the necessary loan being obtained.
GEO. W. CLARKE,
Town Clerk.
Municipal Offices,
Raine-street, Old Gravel-lane, E. 1,
May 2nd, 1922. 8104

## PUBLIC NOTICES

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
GEAR CUTTING.
The Proprietors of British Letters Patent No. 113,363 are PREPARED to SELL the PATENT or to LICENSE British Manufacturers to work under it. It relates to gear-cutting machines and to special form of cutters for producing bevel gears with curved teeth.
Address, B. W. & T., 111 and 112, Hatton-garden, London, E.C. 1. 8078

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
CONTROL MECHANISM FOR TYPE-WRITERS.
The Proprietors of British Patent No. 9254 of 1912 are PREPARED to SELL the PATENT or to LICENSE British Manufacturers to work under it. It comprises mechanism for automatically operating typewriters, &c., in which the key lever system is operated by a grooved cylinder carrying a perforated control strip.
Address, B. W. & T., 111 and 112, Hatton-garden, London, E.C. 1. 8079

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
WATER-TUBE BOILERS.
The Proprietor of British Letters Patent No. 5812 of 1913 is PREPARED to SELL the PATENT or to LICENSE British Manufacturers to work under it. It relates to water-tube boilers with several independent circulation tube sets and provides for the rapid dissociation of the steam bubbles from the header.
Address, B. W. & T., 111 and 112, Hatton-garden, London, E.C. 1. 8080

PATENTS AND DESIGNS ACTS, 1907 AND 1919.
TURBINE GOVERNOR.
The Proprietors of British Letters Patent No. 115,802 of 1917 are PREPARED to SELL the PATENT or to LICENSE British Manufacturers to work thereunder. It relates to the governing of turbines or other engines and comprises mechanism in which the governor is driven through variable-speed friction gearing.
Address, B. W. & T., 111 and 112, Hatton-garden, London, E.C. 1. 8081

TO BRIDGE BUILDERS.
Stirling County Council Invite TENDERS for a STEEL SWING BRIDGE to carry road traffic over the Forth and Clyde Canal at Castlecary. The bridge to be manipulated by man power (two men), and to carry a live load of at least 20 tons over a span of 21ft., and to have a width between parapets of not less than 16ft. The offer to include Supplying and Erecting the Bridge, the Foundations for same, also Timber Dolphin, and everything necessary to hand over the bridge to the County Council in working order.
Further details may be obtained from Mr. Donald E. Cox, Road Surveyor, 48, Barnton-street, Stirling, and offers should be lodged with the Subscriber, Mr. James Learmonth, County Clerk, Stirling, on or before Monday, 15th May next.
The County Council do not bind themselves to accept the lowest or any offer.
JAMES LEARMONTH,
County Clerk.
County Buildings, Stirling,
24th April, 1922. 8031

The Bengal and North-Western Railway Company, Limited.
The Directors are prepared to receive TENDERS for the SUPPLY of :—
STEEL MATERIAL (203 TONS),
as per specification to be seen at the Company's offices.
Tenders, addressed to the undersigned and marked "Tender for Steel Material," are to be lodged not later than Noon on Monday, the 15th day of May, 1922.
For each specification a fee of 10s. will be charged, which cannot under any circumstances be returned.
The Directors do not bind themselves to accept the lowest or any Tender.
By Order of the Board,
E. A. NEVILLE,
Managing Director.
237, Gresham House, Old Broad-street,
London, E.C. 2,
28th April, 1922. 8072

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## PUBLIC NOTICES

### The Corporations of Middlesbrough, Thornaby-on-Tees and Stockton-on-Tees,

having taken over the undertaking of the Imperial Tramways Company, Limited, in the three boroughs, have FOR SALE PORTIONS of the LAND, BUILDINGS, MACHINERY and PLANT which are not required by the Corporations in connection with the running of the tramway undertaking subsequent to the transfer.

The particulars are as follows :—

(1) Buildings utilised by the Imperial Tramway Company for the purpose of generating electricity and consisting of :—

Power-house, measuring or containing 325,610 cub. feet.

Boiler-house containing 193,631 cub. feet.

Offices containing 21,546 cub. feet.

Smoke-stack of best pressed bricks and lined with fire-bricks.

All necessary Foundations for the Machinery.

A Wharf, 200ft. long, abutting on the River Tees, constructed of pitch pine timber and red deal, with 336 sq. yds. of slag pitching.

Boundary Walls, together with Freehold Land, upon which the buildings are erected and adjacent and incident thereto, containing 426 sq. yds. or thereabouts.

The buildings are built of best pressed brick, the power-house being lined with glazed bricks.

The Power Station is equipped with 3 Corliss Horizontal Compound Condensing Engines, direct coupled to 3-phase, 25-cycle, 2500-volt Generators; 2 Rotary Converters, 25 cycle, wound to give 500 to 550 volts on D.C. side; Rotary Converter Booster, Switchboard, Overhead Travelling Crane, Motor-driven Centrifugal Circulating Pump, 3 Babcock and Wilcox Boilers, evaporation 12,000 lb., with Vickers Mechanical Stokers; Electric Motor for driving Mechanical Stokers, Green's Economiser, Coal Bunkers, Coal Elevator (fitted with Avery's Automatic Weigher), Electric Grab Crane, Cables, Piping, Electric Lighting Equipment, and other forms of Plant and Machinery necessary for a fully equipped Electricity Generating Station.

The whole of the above are situate and adjacent to Bridge-road, Stockton-on-Tees, and abut upon the River Tees a little to the west of the Victoria Bridge, which crosses the Tees at or near to that point.

The buildings, which were erected about 22 years ago, are built in a most substantial manner and are in good order and condition.

The plant has likewise been kept in first-class running order.

In addition to the above there is also for sale :—

(2) Plant and Machinery in the Newport Sub-station situate in Newport-road, in the Borough of Middlesbrough, consisting of :—

3 Rotary Converters, Single-phase Air-cooled Transformers, Centrifugal Fans, Electric Motors, Switchboard (13 panels), and all necessary Cables.

(3) Also the following Plant now at Bridge-road premises, Stockton-on-Tees :—

Weighbridge, Hydraulic Lifting Jack, Axle Tester, Hydraulic Rail Bender, Hydraulic Punching Bar, Weld Lamp, Snow Sweeper, Hand Ambulance.

TENDERS are INVITED for the PURCHASE of :—

(1) The LAND, BUILDINGS, MACHINERY and PLANT as described above, situate in or near to Bridge-road, Stockton-on-Tees.

(2) The PLANT and MACHINERY at the Newport Sub-station.

(3) The MISCELLANEOUS PLANT; or, alternatively, Tenders under the head of 1, 2 and/or 3 separately, or any two of them.

Particulars and conditions of sale and permission to view can be obtained from the undersigned, to either of whom sealed Tenders must be sent not later than May 20th, 1922.

Please mark envelopes "Tenders for Tramway Premises or Plant."

The Corporations give no undertaking to accept either the highest or any other Tender or Tenders that may be sent in.

PRESTON KITCHEN,
Town Clerk and Clerk to the Tramways Committee, Municipal Buildings, Middlesbrough;
THOS. DOWNEY,
Town Clerk and Clerk to the Stockton and Thornaby Joint Tramways Committee, Borough Hall, Stockton-on-Tees.

6th April, 1922. 7910

NOTICE.

### Colombo Municipality, Ceylon.

REQUIRED by the Municipal Council, Colombo, Ceylon, an ASSISTANT DRAINAGE ENGINEER.

Candidates must have passed the examination of the Associate Members of the Institution of Civil Engineers and have had a good experience of modern sewerage, sewage disposal and house connection work. They should not exceed 30 years of age and preferably be unmarried.

Appointment, on probation, three years, on a salary of Rs. 9000 per annum, with travelling allowance of Rs. 900 per annum, thereafter permanent, pensionable appointment on incremental basis guaranteed for efficient probationary service, with suitable leave.

Free first-class passage to Colombo and half-pay on voyage.

Application forms and full details can be obtained from the Council's London Agents, Messrs. John Pook and Co., 68, Fenchurch-street, London, to whom applications should apply before May 31st, 1922.

E. H. JOSEPH,
Secretary.
Municipal Council, Colombo.
The Town Hall, Colombo,
March, 1922. 8083

### Corporation of Calcutta.

APPOINTMENT OF EXECUTIVE ENGINEER, WATERWORKS.

1. APPLICATIONS are INVITED for the POST of EXECUTIVE ENGINEER, Waterworks, Calcutta.

2. The salary of the appointment, inclusive of all allowances (except motor car allowance of Rs. 100) is Rs. 1000 to 1500, according to qualifications and experience. The post is for a period of five years.

3. The person appointed will be required to keep a motor car, for the upkeep of which the Corporation will pay him an allowance of Rs. 100 per month. The cost of a motor car will, if desired, be advanced by the Corporation and recovered in monthly instalments spread over 3 years, on the motor car being mortgaged to the Corporation.

4. The appointment is subject to the Provident Fund, leave, and other service rules of the Corporation and may be terminated at any time by six months' notice on either side. The Provident Fund contribution is 8¼ per cent. of the monthly salary and an equivalent amount is contributed by the Corporation and the fund accumulates at compound interest.

5. The selected candidate will be required to devote his whole time to the duties of his office and will not be allowed to take up any outside work. He must reside in Calcutta. He will be liable to removal during the term of his office for misconduct or neglect of or incapacity for his duties. He will be required to submit to a medical examination before joining his appointment.

6. The Corporation will pay his passage (1st class) from London to Calcutta, but he must refund the amount so paid if he gives notice any time within two years from the date of taking up his appointment.

7. He will be required to take up his appointment about the 1st October, 1922, and will receive half-pay for the period occupied by the journey.

8. Preference will be given to candidates who are members or associate members of the Institution of Civil Engineers or Graduates in Engineering of a University, and have had waterworks experience, especially in regard to pumping machinery and modern methods of waste prevention.

9. Candidates are to state their age, qualifications, and experience.

10. Applications will be received in England up to Monday, the 12th June, 1922, by W. C. Easton, Esq., B.Sc., M.I.C.E., 149, West George-street, Glasgow, from whom any other information concerning the conditions of service may be obtained; or in Calcutta up to Monday, the 13th June, 1922, by the Chief Engineer to the Corporation of Calcutta.

B. V. RAMIAH
Secretary to the Corporation.
Central Municipal Office, Calcutta,
The 12th April, 1922. 8074

## PUBLIC NOTICES

### The Municipality of Singapore,

STRAITS SETTLEMENTS.
CHIEF ASSISTANT GAS ENGINEER.

The Municipal Commissioners of Singapore REQUIRE a CHIEF ASSISTANT GAS ENGINEER, age about 30-35, of sound constitution, preferably married. He must have had a good practical education, a regular training as a gas engineer, with general all-round experience, including Carbonising and Water Gas Plant, both in the design and in the construction of new works and in ordinary maintenance and in distribution.

The appointment will be on agreement for three years, with possible extension. The selected candidate must pass a medical examination as to his fitness for service in a tropical climate. A first-class passage will be provided with half salary during the voyage out.

The salary will be 7200 dollars for the first, 7800 dollars for the second, and 8400 dollars for the third year, plus a temporary allowance which now amounts to 15 per cent. of the salary, all paid monthly, the value of the dollar being two shillings and fourpence sterling. For the first year the salary and allowance would be equal to £966 as above, with an allowance for cash transport as may be required on duty.

Applications, stating age and place of birth, and giving details of education, training, and experience generally, and in carbonising machinery and water gas plant, and stating when free, accompanied by copies (only) of testimonials, and also personal references, to be lodged with Messrs. C. G. LINDSAY and PEIRCE, MM. Inst. C.E., 180, Hope-street, Glasgow, Agents to the Municipal Commissioners (from whom further information may be obtained), not later than Tuesday, 16th May, 1922. 8103

## SITUATIONS OPEN

WANTED, for Healthy Locality in the Far East, a First-class ELECTRICAL and MECHANICAL ENGINEER (gentleman, age 30 to 35 years). Must be used to workshop control, factory maintenance, Babcock and Wilcox boilers, A.C. power station design and maintenance.

Salary approximately £1200 per annum. First-class passage. Married man not objected to.

In first instance apply by letter to P5346. The Engineer Office. P5346 A

ACCOUNTANT REQUIRED for West Africa. Age not over 35. Thorough knowledge accounts. Capable of installing and supervising complete system of steamers' running accounts and cost accounts for engineering and repair work.—Address, stating age, previous experience, and salary desired, P5246, The Engineer Office. P5246 A

ASSISTANT ENGINEER REQUIRED for Portugal. Must have experience in Section Draughtsmanship, Hydrographic Surveying, Sounding, &c. Should also have mechanical training and speak and write Portuguese or Spanish.—Apply by letter, with full particulars, to Dr. J. S. OWENS, 47, Victoria-street, London, S.W. 1. 8089 A

ENGINEER, with Extensive Knowledge of Storage and Handling of Grain, Must have had experience in planning and carrying out large contracts. Knowledge of foreign requirements essential. Experienced in negotiating important business abroad. Liberal salary and good prospects.—Box 580, Advertising Office, 84, Queen Victoria-street, London, E.C. 4. 8025 A

FIRM of TIMBER MERCHANTS and SAW MILLERS in Punjab, India, invite APPLICATIONS for POSITION of MANAGER from gentleman thoroughly efficient in organisation and management.

Applicants should give full particulars of experience, stating age and salary expected, and be able to produce satisfactory testimonials as to character and ability.

Address, 8083, The Engineer Office. 8083 A

WANTED, DRAUGHTSMAN (Smart Junior), with shop experience, neat and quick, for Jig and Tool Work and accurate machine details. Richmond district. Particulars of previous experience and salary required.—Address, P5339, The Engineer Office. P5339 A

DRAUGHTSMAN WANTED in the Midlands, Competent man, quick and safe designer of Bridge and Constructional and General Steel Work. State experience, salary.—Address, 8098, The Engineer Office. 8098 A

EXPERIENCED DRAUGHTSMAN REQUIRED; Refrigerating Machinery and Marine Auxiliaries. State age, experience, and salary required.—Address, 8086, The Engineer Office. 8086 A

LEADING DRAUGHTSMAN REQUIRED IMMEDIATELY for large manufacturing firm, to check all classes of work. Must be accustomed to depending on own initiative. State full particulars of training, experience, and salary required.—Address, P5365, The Engineer Office. P5365 A

YOUTH, Just Leaving School, REQUIRED for Engineer's Drawing-office to Operate Photo Printing Machine and make himself generally useful.—Apply by letter, giving references and stating salary required, to P5325, The Engineer Office. P5325 A

WANTED, FOUNDRY FOREMAN. Thoroughly experienced in High-class Light Engine Castings. Must have special knowledge of gun-metal mixtures for heavy pressures and all Admiralty test requirements. About 60 hands employed. None but thoroughly reliable experienced men with good references need apply. Good position for suitable man.—State age, wages, and full particulars to A. G. MUMFORD, Ltd., Culver-street Engineering Works, Colchester. 8064 A

ENGINEER FOREMAN REQUIRED in Chemical Works, London. Able to supervise maintenance and repairs of Plant and Machinery, erection work, efficient boiler control, &c.—Write, giving full particulars of past experience, age, salary required, to T. A., c/o Street's, 30, Cornhill, E.C. 3. 8094 A

## SITUATIONS WANTED

A POWER STATION ENGINEER, with Experience in construction, operation and maintenance of steam turbines and reciprocating engines with all auxiliary plant and boilers, good theoretical and practical knowledge of station economy, experience in manufacture, operation and maintenance of E.H.T. generators, transformers and switchgear, &c., good knowledge of electrical specifications and lay-outs of plant, DESIRES POST as Electric Power and Maintenance Engineer with engineering firm of iron and steel works; age 32, married.—Address, P5287, The Engineer Office. P5287 B

BUYER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT.—Write, Z. M. 613, c/o Deacon's, Leadenhall-st. 8109 B

CAN ANY ENGINEER HELP?—ADVERTISER (32), B.Sc., A.M.I.E.E., married, 11 years' practical experience, constructional and maintenance, used to big jobs, will ACCEPT any reasonable OFFER. Position serious.—Address, P5252, The Engineer Office. P5252 B

ENGINEER, Certified, Well Experienced with steam, electrical, hydraulic, refrigerating, gas, oil machinery, and boilers, workshops, steady man, WILLING to TAKE any JOB. Moderate salary if permanent employment. Excellent references.—Address, P5279, The Engineer Office. P5279 B

## SITUATIONS WANTED (continued)

ENGINEER, Exceptional Experience, 1st Class B.O.T. certificate, A.M.I. Mech. E., present manager of general engineering works (closing down), up-to-date shop management, energetic, tactful handling men; late consulting and works engineer two largest railway carriage and wagon works in United Kingdom; previous assistant to consulting engineer on hotels, institutions, &c. Salary required £500 to £600, with prospects.—Address, 8055, The Engineer Office. 8055 B

ENGINEER, Mechanical and Electrical, Age 23, M.C., B.Sc. (Hons.), practical experience, DESIRES START in practical or commercial side. Willing to start without pay for necessary experience.—Address, P5342, The Engineer Office. P5342 B

ENGINEER, Thoroughly Practical, Combined with theory in steam, oil, gas, mining machinery, office routine, draughtsmanship, &c., late engineer to well-known companies, excellent testimonials, DESIRES APPOINTMENT abroad or home.—Address, P5340, The Engineer Office. P5340 B

ENGINEER (27) SEEKS POST as ASSISTANT; 3 yrs. railway works, 4 yrs. I.C. engines, 2 yrs. D.O., 2 yrs. technical training.—Address, P5348, The Engineer Office. P5348 B

ENGINEER (32), Extra 1st Class B.O.T. Certificate, 1921, Sound practical experience with all kinds of steam machinery, boilers, Diesel, semi-Diesel engines, oil fuel burning, refrigeration, electricity, SEEKS POSITION at home or abroad.—Address, P5362, The Engineer Office. P5362 B

ENGINEER (32), Share, B.O., Technical, Commercial, Internal combustion, printing, rubber, and general engineering; good education, adaptable, inventive, energetic, enthusiastic, diplomatic; £340.—Address, P5331, The Engineer Office. P5331 B

ENGINEER (36), 20 Years' Experience General Engineering, tool-room, millwrighting, present sit. 7 years, would LIKE new ENGAGEMENT as Works Engineer.—Address, P5285, The Engineer Office. P5285 B

ENGINEER, 20 Years' Experience, Willing to become SALES ENGINEER or TRAVELLER for an engineering firm; well up tools, jigs, millwrighting gear, and oil engines.—Address, P5286, The Engineer Office. P5286 B

FERRO-CONCRETE.—SPECIALIST ENGINEER, with wide and varied experience in handling design and construction (bridges, buildings, silos, harbour works, &c.), is OPEN for APPOINTMENT, England or abroad.—Address, P5326, The Engineer Office. P5326 B

FOUNDRY MANAGER DESIRES CHANGE. Sound practical experience, confident, best possible results.—Address, P5360, The Engineer Office. P5360 B

HEAVY OIL ENGINES.—Thoroughly Experienced DESIGNER of both two and four-cycle types, land and marine, is OPEN to ACCEPT ENGAGEMENT with first-class firm; would undertake to design either type for firm wishing to take up this speciality. Highest references.—Address, P5353, The Engineer Office. P5353 B

MACHINE SHOP SUPERINTENDENT, 14 Years' similar position with well-known motor companies, fully alive to up-to-date methods for production; highest references; proved abilities; age 41.—J. F., Brook House, Fordham, Colchester. P5358 B

PRACTICAL ENGINEER-DESIGNER, Disengaged, 30 years' wide experience, mechanical and structural, DESIRES POST, or can privately Undertake Designs, Drawings, Tracings, Quantities, &c. All classes motive power, wide range plants handling materials, machines and structures generally, pipe layouts. Experienced works and drawing-office organisation and management.—Address, P5361, The Engineer Office. P5361 B

PRACTICAL MAN, with Wide Experience in England and U.S.A., would be WILLING to INVEST £1000 and TAKE ACTIVE PART in IRON FOUNDRY.—Address, P5333, The Engineer Office. P5333 B

TECHNICAL ENGINEER and DRAUGHTSMAN REQUIRES POST; 20 years' experience, marine, steam, oil, and general engineering, estimating and correspondence.—H. B., 16, Barons Court-road, London, W. P5349 B

THOROUGHLY Practical ENGINEER SEEKS APPOINTMENT (home); all present abroad. Wide experience with erection and maintenance of Diesel and semi-Diesel crude oil engines, suction gas plants, dredging and mining machinery, locomotives, steam cranes, engineering workshops, &c. Excellent testimonials.—Address, P5290, The Engineer Office. P5290 B

TO ENGINEERS.—A Thoroughly Practical Builder is open to Supervise any description of Building Construction in connection with Engineering Work.—Address, H., 126, Edgware-road, W. 2. P5344 B

WORKS MANAGER, M.B.E., A.M.I. Mech. E., OPEN for ENGAGEMENT; 20 years' experience. The past 10 years with one of the largest motor car manufacturers in the country.

Full particulars on application.

Address, P5334, The Engineer Office. P5334 B

WORKS MANAGER (44), 1st Class B.O.T. Cert., A.M.I.N.A., DESIRES RE-ENGAGEMENT, home or abroad; intimate knowledge of all departments, good disciplinarian, plenty of initiative; excellent testimonials.—Address, P5301, The Engineer Office. P5301 B

A CAPABLE DRAUGHTSMAN REQUIRES a SITUATION. Experience: 10 years rail carriage, motor car and aircraft machine detail design; 4 years mech. and general engineering, specialities, work, detail and design, &c. Moderate terms.—Address, P5263, The Engineer Office. P5263 B

JUNIOR DRAUGHTSMAN (21) REQUIRES SITUATION; 7 years' experience in general engineering, furnace construction, and mech. signs; good refs.—M. C. S., 205, Links-road, Streatham-road, S.W. 17. P5343 B

MECHANICAL DRAUGHTSMAN, with General engineering experience, SEEKS permanent POSITION with progressive firm; conscientious worker.—V. N., 33, Camden-square, N.W. 1. P5304 B

TECHNICAL and GENERAL DRAUGHTSMAN, single, 25, experience structural work, engine design and survey work, diploma and certificates; excellent references.—"C.," 24, Courtney-road, Wandsdan, Croydon. P5293 B

## "ENGINEER" FOR SALE.

OFFER WANTED for COPIES of "ENGINEER," "ENGINEERING," and "AMERICAN MACHINIST," for the years 1913 to 1921 inclusive. The lot or will separate.—Address, 8084, The Engineer Office. 8084 B

For continuation of Small Advertisements see page iii

## COMPANY MEETING

# British Electric Transformer Co., LIMITED.

## PRUDENT PLANNING FOR GOOD AND BAD TIMES

THE 19th Ordinary General Meeting of the Company was held at Winchester House, E.C., on Tuesday, May 2nd, 1922, Mr. A. F. Berry, the Chairman, presiding.

In moving the adoption of the report and accounts, the Chairman compared the items in the accounts with those of the previous year, the principal point being the addition of £47,000 to the Freehold Land, Buildings, Plant, Machinery, &c., the bulk of which represented new plant and machinery installed during the past year. The loan on Mortgage and Interest accrued, amounting to £31,851, had disappeared from the Balance Sheet as being paid off in full. Of the available cash £68,536 had been invested and such investments had since been sold, the money realised being re-invested as opportunity afforded, so that it could be readily used when required for manufacturing purposes. The general charges on Profit and Loss Account were £10,500 more than the previous year, but Gross Profit on trading had increased by £40,000 and Net Profit by over £31,000. Out of the available balance of £97,594 they were able to pay for the fourth year in succession a Dividend of 10 per cent. plus 2½ per cent. bonus and to carry forward £12,709. This was the 19th Annual Meeting, and none of the previous years had shown anything so good.

The Chairman continued :

We have been, and are going, through times of such difficulty of late, that I cannot help feeling that the time may not be distant when the strong confidence of the Shareholders will be needed to help us tide over the one or more years during which it may be impossible to produce the splendid results to which we are by now accustomed and therefore expect.

To-day it would have been pleasant to say nothing but those things that please.

We have, however, at the Annual General Meeting, always endeavoured to give to the Shareholders as much information as we could, and where it has been in any way possible to forecast results we have endeavoured to do so. You may remember that last year we started with 50 per cent. more work in hand (in money value or 30 per cent. more in horse-power) than we had at the beginning of 1920. This year we started with roughly 60 per cent. LESS work in hand (calculated in horse-power—it would be still worse in money value) than we had at the beginning of 1921. This work in hand will not carry with it the same ratio of profit which we looked forward to at our last year's meeting.

The difficulties due to this shortage of work, magnified as they are by strikes and lock-out troubles, cannot be overlooked.

Last year I ventured the opinion that "The next few years will test the capacity of even the best Captains of Industry." Some of us hoped that adversity would bring the different interests in the ranks of industry rather closer together, but we all know there is a wide difference between the wished for and worked for rather than one accomplished.

It appears to me that the active minorities whose business or avowed intention it is to make trouble between the different members of the various British industries' teams are having their own way far too much, and I fear that industry will not prosper as we desire until its natural leaders are actually encouraged to lead. You are well aware that the Stock Exchange, which usually takes its opinions and judgment upon the ideas of those best able to advise it, are indicating in no uncertain way their belief in a return of comparatively good times.

There are signs, too, in the heavier industries of some improvement, but I shall be agreeably surprised if the return of prosperity will be sufficient to enable Ordinary Dividends of any appreciable value to be obtained, at any rate, for the next year.

These extremely bad times through which we are passing can be made to have their uses, and in a Company such as ours there is very much to do in the way of staff work and co-ordination of effort with other sections of the industry. It is only by a continuance and even an improvement on the efforts of office and factory staff that we shall fit ourselves to play our full part in these better times which somewhere ahead we are trusting and working for.

Few of the Shareholders outside this Company realise what an effort it has been to achieve the results we show. They are the result of a carefully thought out policy carried out loyally and efficiently in the main by office and works staff, and it is a pleasure one more to be able to thank all those who have pulled their full weight during the past year and enabled us to accomplish what we have done.

Some of you may be Shareholders in concerns which are considered less fortunate than ourselves. I may tell you that unless our plans had been laid long ago with the greatest prudence and carried out with persistent care, we might, even during this past year, have found ourselves with a heavy loss instead of record profits. I do not mention these facts in any boastful spirit, but I wish Shareholders to appreciate the position and times through which we are passing.

Once again it is my pleasure on behalf of the Board to thank, not only those of the Company's employees who have done their best in the Company's interests during the past year, but also those Shareholders who do their utmost to make it possible for themselves and their fellow Shareholders, including those who work in office and factory, to derive the greatest advantage from this Company by taking an intelligent interest in its products. On the other hand, it sometimes surprises me how little many of our Shareholders do to further their own general and particular interest in this Company, in spite of my requests made from year to year that they should take an interest in their Company's products if they desire to take the maximum interest out of it. The real and ascertained value of what is done by the comparatively few gives a very clear indication of what great benefits to themselves and the Company would result from individual interest and action by the many. For instance, Shareholders might well go into electrical shops of all descriptions and ask about "TRICITY" goods—"'TRICITY' AS ADVERTISED"—How it can help ME—Where—Why—and to what extent. Such action on your part may appear small to you, but please think of its effect taken with that of thousands of others in and out of this Company.

The Report and Accounts were adopted unanimously. 8106

## APRIL.

### Marine Motors for Lifeboats.

IN his paper on "Marine Engine Design as affected by Lifeboat Conditions," read before the Institution of Automobile Engineers on the 13th of the month, Mr. E. F. Evans stated that the marine engine has always been, and still is, the Cinderella of the motor industry, and that with due regard to the significance of the statement, there is no British marine petrol engine on the market even to-day. By a marine engine, Mr. Evans means one that embodies in its design and construction the main essentials of the type. This statement, we believe, has been received with mixed feelings by marine motor manufacturers, but, nevertheless, there seem to be grounds for Mr. Evans' opinion, and in the discussion which took place after the reading of the paper, several members spoke in support of the views put forward. The demands put upon engines for lifeboat service are particularly severe and exacting, and the history of the development of the motor-lifeboat shows that mechanical and electrical defects have been discovered and gradually eliminated. Apart from such essential factors as strength of crank shaft and stiffening of crank cases, thrust bearings and reversing gears, we gather that the main troubles have been defects in mechanical and electrical details, and that the standardisation and perfecting of parts in themselves small, but none the less important, would go far to remove the troubles which have been experienced. The only serious mechanical weaknesses which still survive are those connected with the thrust bearing and the reversing gear, and after trying a great number of gears, the Lifeboat Institution has designed its own gear, which is embodied in its latest engine. The application of the internal combustion engine to lifeboat service has shown that, as far as equipment is concerned, the commercial article is quite inadequate, and detail by detail the special equipment necessary has been designed. Such parts have included petrol cocks, semi-rotary pumps, pressure gauges, electrical instruments, and lamp holders, and high-tension leads. We learn that a rust-proof and water-tight gauge has still to be found, and that the latest practice of the Institution is to enclose all gauges, instruments and switches in an enclosed frame with a carbide capsule to keep them dry. Although the standards of the Lifeboat Institution are high and its requirements do not justify the manufacture of these parts in quantities, yet parts complying with this high standard would undoubtedly find appreciation among the many users of the marine petrol engine.

### Electricity for Agriculture.

SEVERAL new co-operative societies have, during the past month, started upon the construction of electrical generating stations for the distribution of energy in the rural districts of France. The way in which the movement is extending in favour of the general electrification of the country is one of the most remarkable phases of modern progress. It is the direct outcome of the high cost of fuel and the scarcity of farm labour, and the situation of agriculture has now reached a stage when something must be done to employ labour more efficiently and more economically. So numerous are the co-operative societies that avail themselves of the State subsidies for laying down electrical generating plants, that the Government has deemed it advisable to appoint a Commission to prepare a programme for general electrification, the idea being to propose methods best suited to the varying conditions that exist throughout the country. In some cases barrages are constructed across rivers; in others, lakes situated at high altitudes are utilised to provide the necessary head of water. Even streams are employed for the driving of small turbines. Where water is not available, the co-operative societies put down electrical generating plants for supplying current to members and also to the communes, which often contribute to the cost of installation. Some co-operative plants that have been running for more than a year have given results that justify the hope of success in others. In addition to these co-operative ventures, which usually supply local needs, there are the big companies that construct huge installations for utilising the water power of the Alps and Pyrenees, as well as of rivers like the Rhone and Dordogne, while in the colliery districts of the Nord and the Pas de Calais, generating stations are being installed for delivering current under very high potentials over long distances, the distribution over these areas being effected by co-operative societies, which lay down their own transformers and mains. At no other time has there been so much activity in electrical development, and it is due to the absolute necessity in France of economising fuel and assisting in the development of rural districts, which are being rapidly depleted of labour as the result, partly, of the abandonment of the eight hours' day in the agricultural industry. Men are therefore being attracted into the industrial centres, where they work fewer hours for a higher remuneration. The only way to counteract this exodus is to industrialise agriculture.

### The Institution of Naval Architects.

THE spring meetings of the sixty-third session of the Institution of Naval Architects, held during the first days of the month, under the able presidency of his Grace the Duke of Northumberland, were marked by a freshness and enthusiasm which speaks well for the future of the shipbuilding industry, in spite of its present unsettled and depressed state. Sir Westcott Abell's opening paper defined and enlarged a broader conception of British sea power and enumerated some of the economic factors affecting the present unstable conditions, showing how the problem of sea power might be more or less scientifically studied. This year's papers were, on the whole, well balanced, both the scientific aspect of naval architecture and the more practical problem of marine engineering receiving equal attention. Early in the session the papers of Dr. Smith and Mr. J. Wilkie on the double-reduction gears in the ss. Melmore Head provided the basis for a very full and comprehensive discussion of turbine reduction gears. Later, Mr. James Reid discussed the possibilities of further economy in the marine boiler, and a very practical outcome of his paper was the proposal that a joint committee of the Institution of Naval Architects and the Mechanical Engineers and the Civil Engineers should meet to revise the two standard forms of data for boiler trials drawn up some years ago by the Institution of Civil Engineers. It was felt that if a distinction were to be drawn between the furnace efficiency and the efficiency of heat transmission, a great advance would be made and the causes of the various losses and gains of efficiency would be more clearly stated. Mr. James Richardson, in discussing the application of Diesel machinery to single-screw motor ships, described in detail the Beardmore-Tosi engine as installed in the Pinzon, and at the close of his paper Mr. D. B. Morrison announced that his firm—Richardsons, Westgarth and Co., Limited—had placed at the disposal of the Admiralty, the Institution of Mechanical Engineers and the Institution of Naval Architects a Diesel-engined ship for the purpose of tests. The president's appeal for further vessels has now been responded to by other owners and engine builders, and it is hoped that a series of trials will be arranged which will provide valuable comparative data. At the close of the session Mr. R. W. Dana remarked that the present year is the twenty-first year of his secretaryship, and we congratulate him upon the continued prosperity of the Institution, which he serves with such conspicuous success.

### Aeronautical Accidents.

THE month was conspicuous by reason of the number of aeronautical accidents which occurred during its course. Chief among such disasters were the collision on the London–Paris airway and the accident at Brooklands, in which Sir Ross Smith lost his life. The collision occurred on the afternoon of the 7th, and involved a British D.H. 18 machine belonging to the Daimler Hire Company, and a Farman Goliath, owned by the Grands Express Aériens, of Paris. The British machine, piloted by Mr. R. E. Duke, on its way to Paris carrying newspapers, met the French machine, piloted by M. Mire, near Thienloy St. Antoine. A light rain was falling at the time, and visibility was bad, with low clouds. The two pilots appear to have failed to see each other before it was too late to avoid a collision. The right-hand wings of the machines struck, and were torn off, and both craft fell to the earth in flames. The pilot and cabin boy of the British machine, and the pilot, the mechanic and the three passengers on board the French machine were all killed. The disaster, the first of its kind on the route, undoubtedly represents an extraordinary mischance and a matter calling for improved rules of navigation and their more rigid enforcement. It need not be set down as an example of the ordinary risks attending mechanical flight. The accident to Sir Ross Smith occurred on the 13th during his first trial flight on the Vickers' amphibian machine on which he, Sir Keith Smith and Mr. J. M. Bennett proposed to attempt a flight round the world. The machine had previously been satisfactorily flown for half an hour by the builder's test pilot. There can, we think, be no doubt that the spinning dive, in which it crashed to the earth from a low height, was produced by the pilot's lack of familiarity with the control of aircraft of the flying boat type, combined with a want of recent flying practice generally. Sir Ross and Mr. Bennett, who accompanied him on the fatal flight, were both killed.

### The International Railway Congress.

THE ninth Congress of the International Railway Association, at which over 500 delegates reported in five sections—(1) way and works, (2) locomotives and rolling stock, (3) operation, (4) general, and (5) light railways—opened in Rome on Tuesday, the 18th. On the 19th it began the consideration of fifty-five reports on twenty-one selected subjects. The more important reports on all the engineering questions were summarised in our issues of March 31st, April 7th, 14th and 21st, and in the respective sections the "conclusions" of the various reporters on these and the remaining subjects were discussed, and then approved or amended. In most cases this work was soon done; for instance, the question of construction of the road bed and of the track in Section 1 and of bogies, axles and springs of locomotives in Section 2, were disposed of in one morning. Electric traction, on the other hand, took up four sessions, and had to be closured at noon on the Monday. This last subject and light railways drew the biggest attendances, but in the discussion of the latter it was clear that the light railways in the minds of English-speaking representatives were considered as "secondary" lines by the continental delegates, and some confusion was the result. The recommendations of the sections were reviewed by the Congress, sitting in general meeting, on the afternoons of the 26th and 27th, and the whole of the proceedings came to an end on the morning of Friday, the 28th, when it was decided, on the invitation of the Spanish Government, to hold the tenth Congress in Madrid in 1927.

### French Colonial Development.

THE visit of the President of the French Republic to Morocco during the month marks a definite advance in the development of the vast colonial domain in North Africa. For more than three years past, the new French possessions have been organised and large sums of money have been spent upon engineering works of all kinds. Wharves are being built at Casablanca and docks at Dakar, in Senegal, which is to become the most important port on the west coast of Africa. Railways are being constructed and roads built for communication with the interior, while the railway system of Morocco is being linked up with that of Algeria. This is only the beginning of a vast programme, which is to comprise irrigation works of a particularly ambitious character, whereby West Africa is to become a great producer of cotton, cereals and other commodities required by the Mother Country. Africa is regarded as an extension of France, with which communication must be preserved at all costs and under all circumstances, and this view explains the determination of the French to create a sufficiently powerful fleet of submarines and light cruisers to keep belligerent vessels off the sea route. Africa is to be a reservoir of troops, but it is not inexhaustible, for one of the difficulties being met with in the development of the Colonies is the insufficiency of labour. The natural resources of the French Colonies therefore can only be utilised with the aid of the engineer, who will have to supply everything necessary for transport, as well as tractors, with suction gas plants, cultivating, decorticating and other machinery. A great deal of immediately productive work will have to be done to provide some return on the huge expenditure contemplated for colonial public undertakings.

### The New Cunarder Samaria.

THE new Cunard steamer Samaria, which went on her trial trip on April 8th, is one of the post-war fleet of new passenger-carrying vessels which are being constructed for Transatlantic service. Although neither so large nor so fast as some of the company's pre-war vessels, the Samaria is supplied with all the latest improvements in propelling machinery and passenger accommodation. She is constructed for a maximum speed of 16 knots, has a gross tonnage of 20,000, and will accommodate nearly 2000 passengers. She was built by Cammell Laird and Co. at Birkenhead, and is the largest ship of the type ever constructed on the Mersey. She has twin screws, driven by Brown-Curtis turbines and double reduction gearing. Her boilers are oil-fired on the Wallsend-Howden

system, and all her auxiliary machinery is operated on the electro-hydraulic system. In addition to the Samaria, the new one-funnel Cunarders, the Scythia and Albania, are already in the service; the Laconia, Andania, Antonia and Ausonia are approaching completion, and the Aurania, Ascania and Alaunia are still under construction. These new vessels possess the qualities that appertain to great ocean-going steamers—steadiness, stability and luxurious equipment. The turbines of each develop collectively 13,500 horse-power, and the entire machinery space with fuel bunkers is about 40 per cent. less than that required by pre-war ships of practically similar dimensions, power and speed. Most of this economy of space results from the adoption of oil fuel. It means more room for passengers, and should result in greater profit for the owners.

## The Labour Troubles.

DURING the month matters in the engineering industry went from bad to worse. When April opened the lock-out of members of the Amalgamated Engineering Union had been in force for a couple of weeks, but there was still hope that the numerous other unions, covered by three groups, could be kept out of the trouble. Negotiations between representative employers and representative trades unionists were carried on continuously, and at one time—April 4th—it was thought a solution of part of the trouble had been found. So good was the prospect that the employers suspended the lock-out notices against the unions other than the A.E.U. till May 1st, and the discussion of a long draft agreement was begun. Progress for a time appeared to be satisfactory, but unfortunately the efforts to find a solution broke down completely on Good Friday, and a rupture became inevitable. The employers a few days later took steps to restore the notices that had been postponed, which, therefore, came into force on Tuesday last. They expressed, however, their willingness to employ any men who would subscribe to the terms of the memorandum which had been under discussion with the unions. On their part the unions approached the Parliamentary Labour Party, which, on the reassembling of Parliament, requested that an Industrial Court should be set up to investigate the whole affair. The Government consented, and on the 27th Mr. Chamberlain announced that Sir William Mackenzie, Chairman of the Railway National Wages Board, would be President of that Court. Whilst things were going ill in the engineering trades there was a better movement in the shipyard strike, and as a result of a renewed conference, the union representatives expressed their willingness to recommend the members to accept a reduction of 10s. 6d. per week from the date of resumption of work, followed by two further reductions of 3s. each, one on May 17th and another on June 7th.

## Automatic Train Control.

THE report of Major Hall, of the Ministry of Transport, on a collision which occurred early in the morning of February 6th in the Summit Tunnel of the Lancashire and Yorkshire section of the London and North-Western Railway, was issued on the 8th of the month. A goods train of ninety-one wagons—twenty-four loaded and sixty-seven empty—became divided where the gradient in the tunnel—1 mile 1125 yards long—changes from 1 in 330 rising to 1 in 182 falling, and fifty-two wagons and a 20-ton brake were left in the tunnel. Into them a passenger train ran, but not, as might generally be supposed, as a consequence of the section being incorrectly "cleared" on the arrival of the first portion of the goods train at the box in advance. The presence of the passenger train in the section was brought about by the home signal and the starting signal at the box in the rear being frozen in the "off" position. The day in question was a Monday, and the signal box had been closed for twenty-four hours, with the signals necessarily lowered. T ere had been a sharp frost during the night, and the signal connections had become frozen. The goods train had passed whilst the signal box was closed. On the signalman going on duty, he restored the levers working the signals in question, but failed to notice that the signal arms had not responded. The driver of the passenger train saw the signals at "clear" and proceeded. Where the report is of special interest is that Major Hall brings this matter within the purview of the Automatic Train Control Departmental Comittee. He then observes: "Cases of this kind, however, which are not attributable to enginemen's mistakes, can also be covered by a system of control at stop signals, the action of which depends not only upon the position of the signal, but also upon that of the controlling lever in the frame."

## Steam Turbine Reliability and Design.

No I.

DURING the last decade or so the design of steam turbines for power station work has developed entirely in the direction of maximum output at the highest possible revolutions. The main factors which influence the choice of unit continue as before to be, in order of importance, reliability first, followed by economy and first cost in such proportions as the circumstances warrant. Now, while the last-named depends on the overall dimensions—which, in turn, are governed by the revolutions demanded by the generator and by the thermal conditions of operation—the first cost of the turbine does not, as a rule, exceed 8 or 10 per cent. of the total capital cost of large stations, and consequently generally becomes of much less importance than economy. Economy, be it remembered, affects the first cost of both boiler and condensing plant, and consequently in view of the salient importance of reliability as well, it is hard to see why price should figure as greatly as it often does. It is mainly owing to the competitive desire of different builders to reduce their own first costs of manufacture by the production of a smaller unit for the same power that has consistently forced up the speed of rotation to a point which, as regards the turbine, is beginning very seriously to affect the trend of design. The principal element affecting the first cost when the limits as to speed and steam conditions are fixed is the number of cylinders employed, and to a growing extent it is this feature in large steam turbine design which is now so intimately bound up with those of reliability and economy. The relative value of these qualities is best judged by considering them in conjunction. Satisfactory economy and low first cost are useless without reliability; reliability and economy form a very strong combination indeed; good reliability and low first cost are most likely to be obtained only at the sacrifice of thermal economy. Where both load factor and cost of fuel are high this sacrifice can hardly be accepted. It is curious that in order of merit the most important factor takes longest to determine; first cost is settled immediately. This fact has had no little bearing on the question of the adoption of different types of machines.

It is impossible to consider properly these fundamental considerations in relation to modern designs without reference to their development over a considerable number of years. As is well known, the first turbine to be adopted extensively in large units was the Parsons' type; equally notorious is the fact that numerous breakdowns occurred through the stripping of blades. That the Parsons' turbines showed greater economy and lower first cost than were obtainable with reciprocating machinery was indisputable; it cannot, however, be denied that the standard of reliability which was revealed in the first stages of its development, during which period there was little or no adequate comparison possible with other types, was distinctly tarnished in the eyes of station engineers by the early troubles which arose with blading. Although this difficulty has not been entirely eliminated, it is, nevertheless, much less frequent than of yore, and there are very many engineers indeed to-day who have never even seen a badly stripped Parsons' turbine in spite of the colossal horse-power at work. That such a contingency is always present we would remind our readers by the photograph which we reproduce herewith, which shows the minute globules into which blades can be ground and melted in the case of a bad strip. The relatively light nature of the blades, however, prevents material damage to the cylinder, and the trouble is almost always readily repaired without recourse to machine tool operations. The air pump valves generally suffer in a case like this, the *débris* passing right through the condenser and air pump suction pipe.

These blading troubles were caused mainly by:—

(*a*) Distortion of cylinder, due to temperature effect either when warming up or under change of load conditions when the automatic by-pass admits steam of initial temperature at an intermediate point in the cylinder, or to stress occasioned by the thrust of the steam or pull of the exhaust pipes, or to the weight of superposed or attached valves.

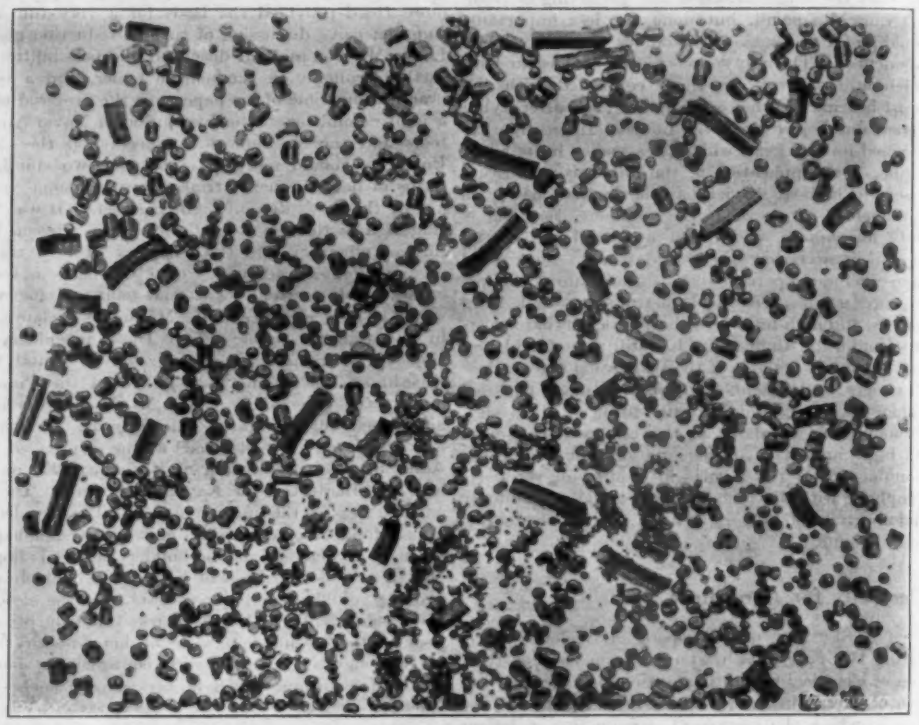
(*b*) Distortion of rotor due to unequal temperature effect when warming up or under changes of load, to sag of rotor or whirling when the rotor is passing through the critical period, or to local deflections of a weak rotor caused by centrifugal stress.

(*c*) To insufficient blade tip clearance.

(*d*) To foreign matter passing into the turbine.

(*e*) To excessive longitudinal stress on the blades.

(*f*) To the continual heating and cooling loosening



TURBINE BLADING DESTROYED BY A BAD STRIP

the blade packing pieces, or to difference in expansion between packing pieces and rotor causing the former to rise in the grooves, or to the binding wire breaking or buckling.

(*g*) To vibration in blades of responsive lengths.

Most of these causes apply with equal force and have been the cause of similar damage to turbines of other than the reaction type.

The remedies which have been gradually successfully applied are as follows:—

(*a*) Stiffer, simpler, and more symmetrical design of cylinder castings, coupled with greater care in warming up and provision for greater flexibility in attached pipes. Removal of weight of valves, &c., off the main casting. In larger units the use of separate high-pressure and low-pressure cylinders.

(*b*) Improved methods of starting up; stiffer rotors; rotor designed so that the critical speed shall be well above the running speed.

(*c*) Blade tips thinned so as to give smaller rubbing surface in case of contact.

(*d*) Is common to all turbines; clean steam and a good strainer are required.

(*e*) Adoption of heavier blade sections.

(*f*) Greater care used with caulking pieces; the introduction of "rosary" blading; the use of steel packing for very high temperatures.

(*g*) Greater care in balancing and heavier blade section adopted. Vibration obviated by attention to position and number of lacing strips.

Besides these improvements to blading, which is the main feature affecting reliability of the reaction turbine, many others have been introduced, such as exhaust end balance pistons, cooling of bearings,

lubrication details, modified glands of governor gear, &c. &c., most of which are now common to all types of machines. Generally speaking, with these remedies to the earliest defects—and it takes some time in service to prove them—the reliability has been very greatly increased and large high-speed sets have now been run for many years without giving the slightest trouble. It is accidents which catch the eye and cause comment; the large number of thoroughly satisfactory units attract little public attention. It was, however, the frequent recurrence of the blading trouble many years ago which gave the impulse turbine its great opportunity. The latter, moreover, though it could not attain the thermal efficiency of the reaction type, could undoubtedly be cheaply produced, and at that period, when the average thermal range and also the load factor were much less than they are to-day, the economical difference was of relatively less importance. In the course of the last eight or ten years, however, pressure, vacua and superheat, and percentage time in operation have been so greatly extended in range that a very different complexion has been put on to the design of large units, and to-day it is useless to deny that turbine manufacturers and power station engineers are faced with a particularly interesting problem in design. When, in 1905, a 5000-kilowatt unit running at 1000 revolutions per minute was a very large high-speed machine, to-day at least 3000 or 3600 revolutions per minute would be adopted for that output, and units of 15,000 to 20,000 kilowatts running at 1500 revolutions per minute are now common in this country. A large number of 12,000-kilowatt two-cylinder Parsons' turbines running at 2400 revolutions per minute have been installed and are the machines of highest thermal economy in Great Britain. The largest unit in the country is the 30,000-kilowatt, 1500 revolutions per minute set supplied to the Rotherham Corporation by the B.T.H. Company. In the United States single-cylinder units of 35,000 and even 45,000 kilowatts are widely installed. These great powers and the high vacua now adopted involve enormous volumes of steam at the low-pressure end, and, with the inevitable reduction in diameters caused by the continual increase in speed of rotation for reasons of first cost, they are becoming increasingly difficult to handle economically unless a two-cylinder turbine design be adopted.

While the general tendency is always towards the greatest output at the highest speed, it is not on account of any electrical advantages that the pace has been forced. In fact, there is a distinct falling off in generator efficiency compared with that of the older lower speed sets and no reduction in cost of construction; but the advantage in increased turbine economy and reduced size, and hence first cost of turbine, completely outweighs it. Practice has recently crystallised into two main types of big machine: the original Parsons' type and that of the single-row pressure-compounded velocity wheel in series, as originally developed by Rateau and Zoelly. By far the largest output of big machines has latterly been by the more numerous builders of the latter type, amongst whom the General Electric Company, of Schenectady, the A.E.G., of Berlin, the Metropolitan-Vickers, and the B.T.H. Company may be mentioned. The manufacturers of the pure Parsons' type have become more restricted and are now mainly represented by the parent company at Heaton and the Westinghouse Electric Company at Pittsburg.

For given steam conditions the efficiency of the turbine depends on the transference of the kinetic energy in the steam to the rotor, minus those losses common or peculiar to the turbine type, such as bearing and mechanical friction, power absorbed in driving oil pump, &c., steam friction losses and leaving losses at the last row of blades. For a given overall heat drop a rough but closely approximate measure of the ratio of blade speed to steam speed on which the blading efficiency itself depends is given by the sum of the peripheral speed multiplied by the number of wheels. This can either be taken as (blade velocity in feet per second)$^2$ × N or in the form of the Parsons K coefficient or (mean diameter in inches)$^2$ × (revolutions per minute)$^2$ × number of moving rows, which is practically the same thing. This latter value is usually multiplied by $10^{-9}$ to give a figure varying from perhaps 60 in an exhaust steam turbine to about 350 for the maximum range of pressure, vacuum and superheat yet adopted. Both expressions are proportional to the volume of the turbine and, consequently, approximately to first costs. The mean ratio of blade speed to steam speed $\frac{V\,t}{V_s}$ is equal to $\sqrt{\frac{K}{2.65\,H'}}$ where H is the total heat drop and K is taken for the moving rows only. The best results are obtained when $\frac{V\,t}{V_s}$ is about 0.5 in the case of impulse turbines and about 0.6 in the reaction design. Obviously, any considerable increase in revolutions enables a "cheaper" K value to be obtained. In the case of the multiple disc type of impulse turbine the cost naturally rises very rapidly with increase in number of discs, owing to the relatively small total number employed. With large diameters—say, 6ft. to 9ft.—these wheels require to be very massive, particularly at the root, in order to secure adequate stiffness, and the pitch may vary from about 6in. to 18in. in consequence. Even with a blade width as great as 1in. in the reaction type the pitch will not exceed about 3in., and at the high-pressure end with ⅞in. blades it is only about 1¼in. N in the above formula and, *ipso facto*, K can therefore be relatively cheaply increased in this case. The proportions of a reaction turbine demand low blade speed and relatively low steam speeds at the inlet end, and up till about 1912 the former did not exceed about 130ft. per second in large units. At the low-pressure end the Parsons Company has always adopted a conservative policy and did not exceed about 300ft. until comparatively recently. Blade stripping in this type has borne no ratio whatever to peripheral speed, and, in fact, in the latest machines, where the velocity has been considerably increased, the reliability in this respect is greater than ever before. In the case of impulse turbines, in order to keep the cost down and the efficiency up, blade speeds have also been increased, and they have extended from about 400ft. per second in 1905–7 to over 700ft. in recent years. In the large majority of cases this high velocity has led to trouble. Numerous instances of foreign machines being completely wrecked by the bursting of these high-velocity discs have involved considerable modification to designs of this type, and one result is that the mean peripheral velocities in the best impulse turbine practice in Great Britain are now restricted to about 550ft. per second, or practically the same as that to which the latest reaction practice has been safely extended. This fact seems likely to have a powerful influence on the future design of large units.

We must continue to keep in mind the development of turbine design from its very early stages in order to appreciate properly the tendencies of to-day. Prior to 1890 all turbines were non-condensing, and even by 1900 only about 5000 horse-power had been installed. When in 1899 a 1000-kilowatt, 1500 revolutions per minute set was ordered from Messrs. C. A. Parsons and Co. by the city of Elberfeld, it was deemed to be a very large machine, and for the sake of reliability it was made in two cylinders—a tandem high-pressure and low-pressure on the same shaft separated by a loose coupling. It was shortly afterwards followed by a 3000-kilowatt, 1350 revolutions per minute set, built by Brown, Boveri and Co., for Frankfürt, which showed remarkable economy; but even then it was realised that the first cost of the two-cylinder design was high and a reversion to the single-cylinder type was made, units of 5000 kilowatts at 750 revolutions per minute being adopted in America and Switzerland some time before a similar power was reached in this country. The 3500-kilowatt, 1200 revolutions per minute Parsons' set installed at Carville in 1906 gave excellent results at this period, a consumption of 13.19 lb. per kilowatt-hour being obtained with 200 lb. pressure, 120 deg. Fah. superheat and 29.04in. vacuum. This machine has a "K" value of 180 and a thermal efficiency ratio of 65 per cent. At 5164 kilowatts the total consumption was 68,180 lb., and this quantity of steam involves no difficulty in handling through the low-pressure blading at 1200 revolutions. Very different, however, is the case when we get 15,000 and even 30,000 kilowatts at the same speed. In order partly to avoid high peripheral speeds, partly because with the greatly increasing temperatures it was becoming advisable to confine their effect to the high-pressure end, partly to circumvent the problem of critical speed and for other reasons, when the race for maximum powers and speeds began the Parsons Company re-introduced the two-cylinder design, with the low-pressure end constructed as a double-flow machine, thus giving increased exhaust area through the low-pressure blades. This is precisely what was done in marine reciprocating engine practice about fifteen years previously, when, in order to avoid the many disadvantages attaching to excessive diameter of the low-pressure cylinder, in a three-cylinder triple-expansion engine this cylinder was subdivided into two, and a four-crank design adopted. It was a longer, heavier, and more expensive engine certainly, but it solved the problem of getting the steam in and out of the low-pressure cylinder satisfactorily and also gave a much steadier running engine. It is well to bear in mind that the former was gladly accepted for the sake of the latter in considering turbine design to-day. The low-pressure unit in large power geared marine turbines is now very often a double-flow machine. The largest single-cylinder unit installed by the Parsons Company was of 8500 kilowatts at 1500 revolutions per minute—a 1916 design. The development of the Parsons machine is best indicated by the accompanying table, which gives the dates, output, speed and dimensions of the machines built during the transition period of recent years. That in 1913 only 750 revolutions per minute should have been adopted for the 25,000-kilowatt Chicago machine may seem surprising, considering that only two or three years later 1500 revolutions per minute were adopted by impulse turbine builders for that power. It was certainly a very large machine, but it was by no means as heavy as, nor did it cover any more floor space than, the 25,000-kilowatt, 1500 revolutions per minute General Electric Company's two-cylinder machine of two years later. It was just about this time that turbo-alternator design was ripe for another advance in speed and power. For 50 cycles it was a question of 750, 1500, and 3000 revolutions per minute, and to-day we find 12,500 and 15,000-kilowatt machines of the latter speed and units up to 35,000 kilowatts in one cylinder at 1500 revolutions per minute.

Except in a limited number of cases some years ago, the two-cylinder design was practically confined to machines of the reaction type. On the other hand, impulse builders strove to keep their first costs down as low as possible by adhering to the single-cylinder design. To do so without too great a sacrifice of economy it was necessary to keep the value of (blade velocity)$^2$ × number of stages as high as possible, and the temptation to increase the former rather than the latter undoubtedly proved too great. The high and complex stresses which were occasioned by the increase in peripheral velocity were unexpectedly run up to a point which has resulted, mainly, it is true, in the United States, in a number of cases of these over-stressed discs bursting with almost disastrous effects, and in several cases of machines of 30,000 kilowatts in big power stations in Boston, Chicago or Philadelphia the turbine and sometimes the alternator have been completely wrecked from this cause. In his recent paper to the Institution of Electrical Engineers, Mr. Baumann quoted a number of instances of accidents of this nature, both British and foreign, and in most cases it appears that fatigue of metal due to centrifugal stress arising from the speed aggravated by complex and unknown stresses caused by any vibration that may occur, has been responsible for starting cracks at highly stressed points such as between balancing holes, &c., which have eventually resulted in fracture. The actual danger created by pieces weighing several hundredweight parting company at a speed of several hundred feet per second can well be imagined. The root of this evil undoutedly lay in the competitive attempt to pull down size and cost by running up the blade speed, i.e., the stress. It has got little to do with the type of turbine or maker, and stiffer discs at slightly lower speed work excellently, as is proved by the number of machines in satisfactory operation. The point with which designers of large-power high-revolution impulse turbines are unquestionably faced is whether in stiffening the discs and reducing the blade speed they will not require to abandon the single-cylinder design simply because they cannot otherwise obtain an adequate K value for purposes of economy. On the other hand, there is undoubtedly a high manufacturing cost and the pitfall of critical speed to be considered. Finally, when so many machines have so far run without trouble, considerable discrimination must be used in attaching too much importance even to a number of similar accidents.

TABLE I.—*The Development of the Parsons Turbine.*

| Date. | Kilowatt output. | R.p.m. | Installed at. | Blade speed. First row. | Blade speed. Last row. | Diameter of low-pressure drum. | Height of last blade. | Total heat drop. | K. | Thermal efficiency. | Thermo-dynamic efficiency. Actual. | Thermo-dynamic efficiency. Corrected. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | f.p.s. | f.p.s. | Inches. | Inches. | | | | | |
| 1907–10 | 3500–5000 | 1200* | Carville | 127 | — | — | — | 403.0 | 180 | — | 65.0 | — |
| 1912 | 6000–8000 | 1000 | Lots-road | — | 325 | 66 | 8 | 369.0 | — | 23.31 | 71.8 | 72.26 |
| 1913 | 25,000 | 750 | Commonwealth Edison, Chicago | 135 | 345 | 86 | 19 | 408.0 | 220 | 25.29 | 77.3 | 77.5 |
| 1915 | 15,000 | 1000 | Lots-road, Chelsea | 174 | 393 | 75 | 15 | 403.0 | 205 | 23.31 | 71.8 | 72.26 |
| 1916–20 | 11,000 | 2400 | Carville | 230 | 578 | 47 | 8 | 460.0 | 330 | 25.41 | 73.1 | 71.32 |
| 1920 | 12,000 | 2400 | Dunston | 230 | 578 | 47 | 8 | 420.0 | 330 | 24.67 | 75.2 | 73.23 |

* Single cylinder, others all two cylinder.

A YOUNG Australian farmer, Mr. Ian Munro, has, it is reported from Adelaide, invented a successful automatic stooker. The appliance, which is said to fit on to any reaping machine, collects the sheaves, and builds them into a stook on a platform, which takes the place of the sheaf carrier on the ordinary binder. When sufficient sheaves have been placed in position to make a stook, the platform is dropped, the drop acting as a consolidator, so that the completed stook is sufficiently well packed to withstand any wind. The device has been in operation this year, and it is claimed by those who have seen it that the work is quite equal to the average standard of manual labour. The extra draught on the binder necessitates the addition of a horse to the team.

# A Visit to Carels' Factory at Ghent.

No. I.

WE usually associate the reconstruction and re-equipment of a large engineering works with a gradual replacement of the older machine tools, the adoption, perhaps, of better crane facilities and more modern means of transport, and the addition from time to time of new shops and foundries as these may be required. Seldom in the history of an old-established engineering firm do circumstances arise which permit, not only of large extensions being made to the works themselves, but which at the same time allow of the old plant being practically wiped out, and new machine tools installed throughout the shops, such tools having been specially chosen and grouped, with a view to ensuring the most rapid and economical production of the firm's special manufactures.

It was this thought, perhaps, which was most vividly before us as we recently inspected the Carels works at Ghent, after the damage done by the Germans during their occupation had been made good. We show in Fig. 1 a view of that section of the building which contains the commercial and technical offices and that portion of the works devoted to welfare, and in Fig. 2 a ground plan of the present factory is reproduced.

As the circumstances attending the despoiling of the plant at the "Usines Carels Frères" by the German military authorities, and the consequent reorganisation of the firm after the Armistice, under the new title of the Société d'Electricité and de Mechanique Procédés Thomson-Houston and Carels, may not be familiar to our readers, we may briefly recount them as follows:—At the outbreak of war the works of Carels Frères were engaged in the manufacture of drop-valve steam engines, and Diesel oil engines, both for land and marine work, whilst the foundries were occupied with the production of large castings. At that time, the total area over which the works extended was approximately 11¼ acres, of which 9½ acres were occupied by covered workshops giving employment to about 850 workers in addition to the administrative and technical staffs.

During the first few months of the war work was carried on with difficulty and with a much depleted staff, an important order then in the shops being that for two 1500 brake horse-power Carels marine type reversible engines ordered by the British Admiralty, which unfortunately were never delivered to this country. On the entry of the German armies into Ghent, Messrs. Carels having definitely refused to take any part in assisting with repairs, the factories were requisitioned by the military authorities and about three-quarters of the plant were dismantled and sent to Germany to be used in munition factories. At a later period the works were re-equipped by the Germans, machine tools for the purpose being brought from other despoiled works in South Belgium and the North of France.

During the latter part of the war the works were entirely staffed by Germans, and more than 2000 German workmen were engaged on gun repairs. During the whole occupation it is estimated that several thousands of guns were repaired by the Germans, and from 200 to 300 guns were constantly in the shops. A further section of the works was equipped by the German authorities for keeping in repair the various steam tugs used in connection with their inland canal transport service. Towards the end of 1918, when the German forces were driven back by the Allied armies, the works were again depleted. On this occasion practically everything was removed from the shops excepting the electric cranes, which should have been destroyed, but were overlooked in the hurried departure of the enemy. The state of the shops in their despoiled condition is depicted by two of the engravings we reproduce in our Supplement. Immediately after the Armistice a brave effort was made by Monsieur Duez, the works manager, to re-start the factory. The only plant available at the time consisted of a small electric motor and some machine tools, but a beginning was made with this slender equipment, and in a few days the works were busily engaged repairing steam engines for the large number of partly dismantled and despoiled works, which were then to be found in all parts of Belgium and Northern France. Later, the plant was increased in size when a shipload of machine tools taken from Ghent was discovered on a German vessel in Antwerp Harbour, and its cargo was finally restored to the works. Early in 1920 a new company was formed, and the Carels interests were merged with those of the Thomson-Houston group of companies. Additional adjoining land was acquired, and the new buildings shown in Fig. 1 were commenced. By the end of 1919 the output of the factory had already reached that of the year prior to the war, so that a single year had sufficed to repair the ravages effected by the German occupation of the works. Fig. 2, already mentioned, indicates the lay-out and arrangement of the present factory, which was finally completed late in 1920, and which has now been in full operation for close upon two years, during which time a steady output of work has been maintained. The total area of the new works is about 15½ acres, of which over 13 acres are occupied by covered workshops. At the end of 1920 employment was found for 1535 workers and an administrative staff of about 250 persons, and at the time of our visit those numbers had not changed very much.

FIG. 1—FRONT VIEW OF MAIN BUILDING

The works are furnished with electric power, which is generated by both steam and Diesel plant installed within the works in the company's private power station. The Diesel plant consists of one 600 brake horse-power engine and a further unit of 100 brake horse-power, both coupled direct to electric generators, while the steam engines are two in number, one of 500 horse-power and one of 200 horse-power. Special transformers are installed for high-tension testing purposes.

The work of the factory can be conveniently grouped under five headings, namely, Diesel engine construction, steam engine construction, locomotive repairs, foundry work, and the making of electrical machinery. The last named includes the building of small electric motors, large generators and alternators and transformers. As this electrical machinery is manufactured under similar methods to those in use in the Schenectady works of the General Electric Company and the works of the French Thomson-Houston Company, we do not propose to give an account of it in our present article. It is interesting, however, to note that alternators up to 2000 kVA capacity have been constructed, and transformers up to 1600 kVA capacity are on order. The engravings reproduced in our Supplement also show the arrangement and lay-out of the various machine shops, assembling

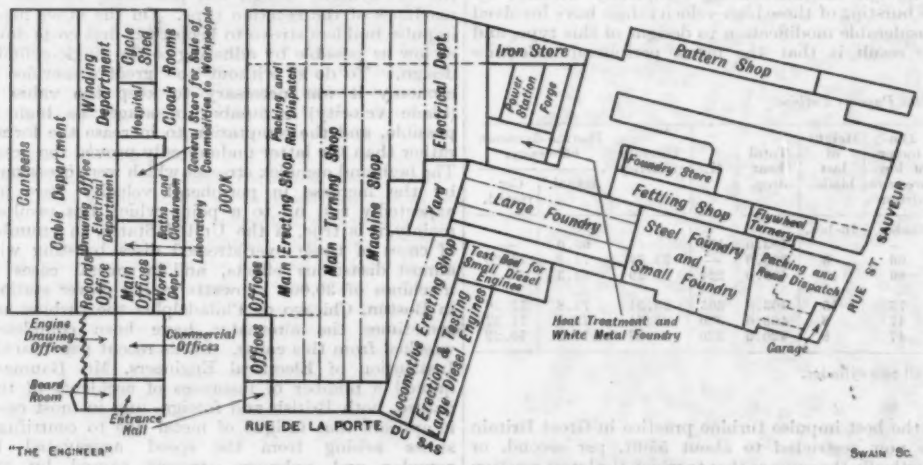



FIG. 2—ARRANGEMENT OF CARELS' RECONSTRUCTED WORKS

FIG. 3—BESSEMER CONVERTER IN THE STEEL FOUNDRY

and erecting shops. In arranging the plant, special attention has been devoted to the grouping of the machine tools in such a way as to facilitate the progress of work through the shops. This is par-

ticularly noticeable in the main turning shops, and in that section of the works allotted to the heavy drilling, planing, and slotting machines. In the

FIG. 4—4000-H.P. UNIFLOW ENGINE CYLINDER

FIG. 5—CYLINDER FOR CROSS COMPOUND ENGINE

electrical departments the grouping of the plant is such as to enable consecutive operations to be carried out with the minimum amount of lifting.

The machine tools throughout the works are predominantly of American make, with a fair proportion, however, of British and French tools. Some of the machines originally removed from the works have now been restored by the German Government under the reparations scheme, and we learned on inquiry that about 150 such machines have been returned, of which about 100 have already been repaired and put into use. The range of sizes of both small and large machine tools is very complete, and the section of fully automatic tools which is arranged in one of the upper galleries has been augmented by the addition of a series of Potter lathes. A group of smaller lathes is devoted to the training of the apprentices, who work under the tuition of skilled instructors. A special turning shop has been set apart for fly-wheel construction, and fly-wheels up to 25ft. in diameter were seen in course of completion.

A large number of steam engines and Diesel engines of various types was under construction at the time of our visit, and we shall refer to them in detail in our second article. The locomotive erecting shop was filled with work for the Belgian State Railways, and some fifteen to twenty locomotives were, at the time of our visit, under repair. Although much has been done towards setting in order the Belgian railways, we understand that for some time to come a steady flow of locomotive repair work may be expected. In the electrical departments an output of about thirty small motors per day is being maintained, and several large dynamos and transformers were seen in progress of construction. The foundry, which was extremely busy during the whole of last year, is now only moderately employed, and the present less busy time is being used to complete the extensions and re-organise the equipment to reach an output of 700 tons per month, the present output being about 500 tons. The moulding shops are very extensive, and are excellently served by a series of eight cupolas, arranged all along one side of the foundry. One of the large moulding shops is in process of being re-equipped as a steel foundry, and Fig. 3 shows the Bessemer converter which has recently been installed for the making of steel castings up to 1½ tons in weight. When this plant is completed it will supply all the steel castings required by the works, in addition to those required for outside contracts.

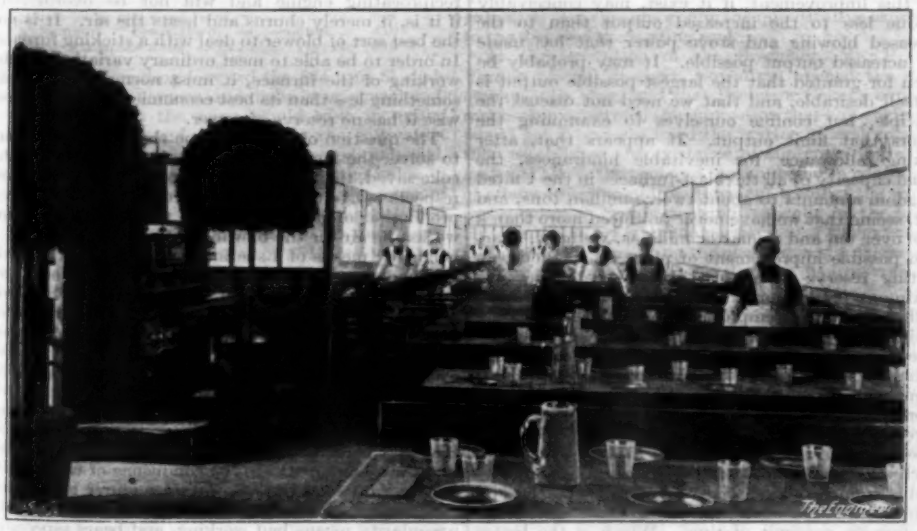


FIG. 6—VIEW IN THE MEN'S CANTEEN

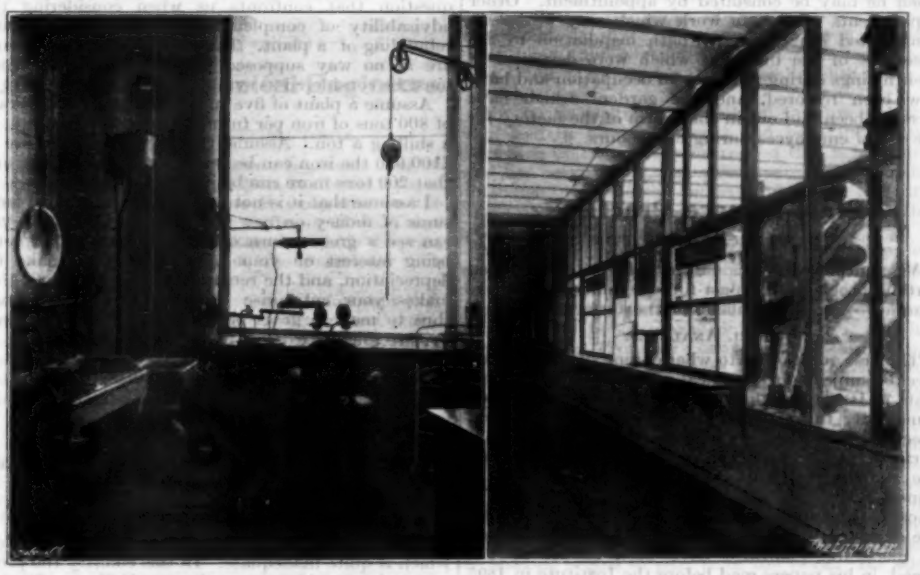


FIG. 7—DENTIST'S OPERATING ROOM

FIG. 8—THE GENERAL STORE

One of the features of the newly planned small foundry equipment is the series of hydraulic moulding machines, which have been installed for producing in quantity the various small castings required by the electrical departments for the construction of the small-type motors. To facilitate rapid production and ease of handling, aluminium moulding boxes and aluminium patterns have been introduced with very successful results. In a gallery adjoining the small machine moulding foundry a sand-preparing plant has been installed. As the sand is shaken out from the cast and completed moulds it is conveyed by an elavator to the gallery, where it is passed through a series of sand-dressing machines and finally delivered to storage bunkers alongside the moulding machines. An ample and fresh supply of sand is thus always assured. In the main foundry we saw a large variety of work in progress, and loam moulding was much in evidence. Indeed, in the Carels foundry loam moulding has been for many years practised as a fine art. While inspecting the foundry, we were particularly interested to see the partially completed mould of the main frame of a large uniflow engine designed to develop 4000 brake horse-power in a single cylinder, and one of the largest engines of this type yet constructed. This extremely large and somewhat complicated mould was being slowly built up, brick by brick, and tile by tile, directly from the drawings, scarcely any strickles or patterns being used. Fig. 4 shows the cylinder casting for this large uniflow engine, while the low-pressure cylinder casting for a large cross-compound engine is illustrated in Fig. 5. The gross weight of the first casting, when removed from the mould, was 38 tons, and after stripping and dressing its net weight is approximately 20 tons. Carels' foundries are capable of handling castings up to 50 tons in weight, and are evidently well adapted for dealing with bulky and heavy work. Another of the firm's special manufactures is the production of large grooved fly-wheels for mill engine drives, and wheels of this type were seen in the moulding shops. Such wheels are struck up in loam, and are made in diameters up to 25ft. to 30ft. The work calls for skilled loam moulding, and some good examples were seen.

As may be expected, the pattern shops are not extensive, since the majority of the castings are loam-moulded, and comparatively few patterns are required. The pattern and woodworking departments are, however, well equipped with machinery, and are thoroughly up to date in every respect. Large stores are available for the storage of patterns, and in general the works are well provided with storage accommodation, both for raw materials and partly finished component parts which are waiting to be assembled.

An interesting side of the works organisation proved to be the work-planning office, where, in the centre of the factory, the drawings are received from the technical drawing-offices and the work allocated to the various departments. The costing system was framed on American lines, but it has been modified and adapted to Belgian conditions, and by means of a card system an account is kept of the whereabouts of each part or series of parts, and its progress is guided through the series of consecutive operations through which it may be required to pass. At the same time the cost of each operation is recorded, and from the record so obtained the basis price is fixed for any new operation. Mention need scarcely be made of the mechanical and electrical drawing-offices, and the administrative and commercial offices, all of which are well suited for the control of a large works. Much attention has been paid to welfare work, and we may perhaps close this first article with a brief account of the activities of the company in this direction. Shortly before the war it was proposed

to build and equip a works canteen, but this project never matured. With the formation of the new company it was, however, found possible to include the canteen in the new building erected in 1920 and shown in Fig. 1, the upper part of which is devoted along its entire length to this purpose. Separate provision is made for the male and female workers and for the staff, and a well-equipped kitchen has been installed, where upwards of 300 meals per day are prepared and served at a charge of about 2f. per head. In Fig. 6 we reproduce a view taken looking down the length of the men's canteen. Owing to the shortage of commodities in Belgium, which continued long after the cessation of hostilities, the firm found it necessary to assist their workers in some measure by enabling them to obtain supplies of commodities at reasonable prices, and for that purpose a general store was opened in December, 1920. By careful buying in wholesale quantities and with small operating costs, it has been found possible to supply commodities to the workers at prices fully 20 per cent. below those obtaining in retail commerce. This venture has been much appreciated, and its continued success seems assured. A view of the general store from which sales are made, and which is accommodated in the main office buildings, is reproduced in Fig. 8.

Another side of the welfare work which has received careful attention is the provision and equipment of a complete hospital, including a dental department. The hospital is situated in the main office buildings. In addition to the surgical and dental operating rooms, a sick ward containing beds, along with a rest room and dispensary, is provided. We show in Fig. 7 a view of the dental operating room which, like the surgical operating room and sterilising room, is equipped with the most modern instruments and appliances. The hospital is in charge of two medical officers, one of whom is always on duty and ready to attend to any accident and to perform surgical work. The dentist also visits the hospital at stated hours, when he may be consulted by appointment. Other departments of welfare work which may be briefly enumerated are the spray bath installation in the basement of the buildings which were despoiled of their fittings during the German occupation and have now been restored, and the gardens which have recently been laid out in the centre of the factory for the use of employees during meal hours.

## Blast-furnace Practice.*

By FRANCIS SAMUELSON.

My purpose in this address is to touch upon certain problems of blast-furnace and steel works practice—more particularly of the former.

### Steel Analyses.

The first question is, to what extent should finished steel be subjected to chemical as well as to mechanical tests? It may be that it would be possible, at least somewhat, to relax the severity of the chemical specifications, when the mechanical specifications are perfectly met. This opens up the question of whether the present chemical specifications are or are not unnecessarily severe, and whether the limits for phosphorus, sulphur, copper, and arsenic in particular are or are not unnecessarily low. Arsenic and copper in moderate quantities have been shown by Dr. Stead, in his papers read before the Institute in 1895 and 1916, to be quite harmless in steel. In so far as the specifications are, or may be, too low, they do or may cause unnecessary cost in working, and greatly restrict our sources of supply, giving an artificial value to certain very pure materials and unduly depressing others, somewhat less pure, to the manifest advantage of the few and to the very great detriment of the many, and to the loss of the world in general, and perhaps more particularly of this country, which is unnecessarily debarred from using the whole of its resources in the most advantageous way. As an example, certain ores, which under present conditions can only be used in the basic process, might perhaps, under more liberal specifications, be used in the acid process. In some cases their cost would be prohibitive for use in the basic process, and, if not used in the acid, they could not at present be used at all.

There seems to be considerable variety in the amount of phosphorus and sulphur allowed in rails by various railway companies, the lowest being 0.04 per cent. for either element, and the highest, the British Standard Specification for bull-headed rails being 0.075 per cent. for phosphorus and 0.08 per cent. for sulphur. Two railways, over whose lines many of the same trains run, vary by 0.02 per cent. for both elements—0.05 in the one case and 0.07 per cent. in the other—with practically the same carbon. If one of these railways be not endangering the lives of its passengers, the other is needlessly increasing the cost of making steel rails and restricting the use of certain ores.

Is it not the case that foreign steels are imported into this country with higher limits than are allowed by our own authorities, and that no failures can be shown to be attributable to this fact?

### Pig Iron.

The next two questions deal with the future of processes. Is it certain that in cases where the materials from which the pig iron has perforce to be produced are at once sulphurous and siliceous, and where it is difficult, if not impossible, without unreasonable cost, to make pig iron low alike in sulphur and silicon, it would not pay to make the iron low in sulphur and somewhat high in silicon, and to get rid of much of the silicon by means of a more active mixer than those generally in use before the iron goes into the open-hearth furnace? The advantage in the blast-furnace is clear: it is cheaper to make foundry than forge iron. The difficulty of making an iron that suits the steel makers is great, and a furnace that is easy to work is an economical furnace. Is it not probable likewise that large quantities of ores containing phosphorus only a little above the present and the possibly more generous future limits will be used to make pig iron to be treated by modifications of the basic process such as a preliminary treatment for removal of phosphorus in a basic-lined mixer, the steel being finished in an acid-lined furnace? If ores could be dealt with in some such way our resources would be extended, and there would be a tendency to equalise their values either by cheapening the purer ores or by giving the less pure such increased value as would enable some of them to come into a market from which the discrepancy between their value and the cost of winning them at present excludes them.

### The Economics of Scrapping.

Most of the very numerous problems relating to the blast-furnace have been, to a very large extent, worked upon, but probably very few, if any, of them have been completely solved. The largest problem, and one that covers the whole field, is the question as to what extent the known deficiencies of British plants suggest a policy of scrapping and rebuilding, and, on the other hand, to what extent we can improve matters with a moderate expenditure of capital. The following is an example of the sort of question that confronts us when considering the advisability of complete or partial scrapping and rebuilding of a plant. The figures are arbitrary and are in no way supposed to represent facts: they must be considered as symbols only.

Assume a plant of five furnaces making an average of 800 tons of iron per furnace per week at a profit of a shilling a ton. Assume that by an expenditure of £100,000 the iron can be made for 8d. a ton less, and that 200 tons more can be produced per furnace.

I assume that it is not worth while to expend large sums of money on new plant unless you think you can see a gross return of 20 per cent.—5 per cent. being interest on your capital, what you like for depreciation, and the remainder being the profit that makes your enterprise worth while. You require thus to make a gross profit of £20,000. The result you are to get is—

| | Tons. |
|---|---|
| Original output .. .. .. .. .. .. | 208,000 |
| Additional output .. .. .. .. .. | 52,000 |
| New output .. .. .. .. .. .. .. | 260,000 |

At 1s. 8d. profit = £21,666.

From this you have to deduct the profit you were getting before, which was 208,000 tons at 1s. = £10,400. The net result of your expenditure of £100,000 is that you get an additional return of £11,266 per annum—11¼ per cent. on your outlay, which is quite inadequate. In this country the profit on pig iron making is not large. If the profit were much larger, that would be a factor in favour of the scrapping policy.

Another question is that of the effect upon the quality of the iron of increased output per furnace. There seems to be some reason to suppose that increased output improves the silicon-sulphur ratio, but this improvement, if it exist, may conceivably be due less to the increased output than to the increased blowing and stove power that has made the increased output possible. It may probably be taken for granted that the largest possible output is in itself desirable, and that we need not discuss the principle, but confine ourselves to examining the factors that limit output. It appears that, after making allowance for inevitable hindrances, the actual capacity of all the blast-furnaces in the United Kingdom amounts to about twelve million tons, and that, seeing that we have never produced more than a little over ten and a-quarter millions, we have, apart from possible improvement of plant or methods, an existing reserve of about 17½ per cent. over the maximum production hitherto attained. We have in this country attempted to get and succeeded in getting larger outputs from our furnaces than they were designed for; this has meant over-driving or, perhaps I should rather say, driving up to the maximum capacity of the plant, leaving no margin of reserve power for emergencies. I believe our usual system is to endeavour to maintain a fairly constant pressure of blast, leaving it to the furnace to say how much air it will take, and that we do not commonly in this country adopt the system by which the aim is to keep up a constant volume of air going through the furnace per unit of time. Which is the better system? The constant-volume system certainly requires elasticity in the blowing apparatus; that is to say, that it must work normally at less than full capacity, having a reserve of power with which to deal with difficulties. Whichever system be best, there can be little doubt that a considerable reserve of power is desirable.

Here, in our old plants, our troubles begin. If we increase our engine-power, we have not enough stove-power: we may add new stoves, if we have room for them, which often we have not: we may raise the height of the old ones, if they are strong enough to carry the added weight—even then they are probably not strong enough for the new pressure. If we surmount the stove difficulty, we find our mains and connections are not large enough to take the increased volume of air. If, by partial scrapping, we get over all these difficulties, we are apt to find that our yard is not equal to the increase of traffic. So that there really seems no half-way house between letting moderately-well alone and complete scrapping: we can get a certain distance on the road to improvement, but not as far as we should like.

### Output of Blast-furnaces.

Having assumed that large output is desirable, the question presents itself: "What is the largest desirable output per furnace?" This question may be left to time to answer. It is never safe to prophesy what will be the future limits of size of anything. The output of a furnace depends upon the amount of coke burnt in it, the quantity of iron obtained per unit of coke, or, as it is more usually stated, the weight of coke consumed per ton of iron, and the amount of air blown in to burn that coke. You cannot get a given output without a minimum of coke and a minimum of air. But you may blow in more air and burn more coke without getting any increase of output. You are then using power and fuel wastefully, and possibly making slag of your lining, the reason being that you are driving your gases too fast through your furnaces to allow them to do their work efficiently under the existing conditions; perhaps it is a lack of porosity in the materials themselves, or their disposition relatively to one another, that causes them to refuse to utilise more gas to good purpose.

Within the past forty years the output per cubic foot of capacity has increased many times after all allowance has been made for difference in material treated. So long ago, however, as 1890 Gayley described a furnace making, in its best week, 135 tons per 1000 cubic feet.

Closely connected with the cubical capacity of a furnace is its shape or "lines." We do not nowadays see furnaces built in all sorts of odd shapes like pears and onions and chessmen. A furnace now generally consists almost entirely of cylinders and truncated cones, subject to a little rounding off where these figures meet in order to avoid dead space; in other words, its lines are mainly straight; there are no bulges and few curves, and such curves as there are of a nature to decrease rather than to increase the cubical capacity, which is thus limited to the minimum required by a few necessary dimensions. If any increase in the size of blast-furnaces is to be expected in the future, it seems probable that it will be rather in the horizontal than in the vertical dimensions, the present simplicity of lines being retained; that is to say, that increased capacity would not be obtained by outward swelling.

When the output, dimensions, and lines of the furnace have been decided upon, the question of the type of blowing engine has to be considered. It is probably generally accepted now that where there is use for surplus gas the gas engine is the correct motor. The gas engine involves gas-cleaning plant, and is otherwise more costly than steam engines and boilers. If surplus gas be not required, it is a question between reciprocating engines and turbines. The turbine saves in first cost, in space, in housing, in oil, and in running cost. It is less positive in action than the reciprocating engine and will not be overdriven; if it is, it merely churns and heats the air. It is not the best sort of blower to deal with a sticking furnace. In order to be able to meet ordinary variations in the working of the furnace, it must normally be run at something less than its best economical speed; otherwise it has no reserve of power.

The question of dry air is one that may take years to solve, the factors involved being the value of the coke saved, the value in the gas of coke burnt in other respects wastefully, and the profit in the increased production of iron. It is said that at the Rombas works the air for the blowing engines is taken from a height by means of a suction tower, and that this air is found to contain on an average 12 per cent. less moisture than the air at ground level. By this arrangement the total moisture would be reduced, but the irregularity, which is the most objectionable factor, would remain. In America the low value of coke seems to have retarded the extended use of the costly apparatus required for drying the air; in this country the small average profit on pig iron has had the same effect. Blast-furnace managers are agreed that the chief advantage of dry air is the greater uniformity it imparts to the conditions of working.

Uniformity is a great factor in economy. Regularity of working means, as a rule, good working; certainly irregularity means bad working, and bears especially upon coke consumption. It is impossible closely to follow a furnace working irregularly and give it always exactly the coke it wants; moreover, any additional coke charged takes time to produce effect, and consequently the furnace must have on the average more

* Iron and Steel Inst., May 4th, Presidential Address. Abstract.

coke than its average requirement to be on the safe side. Any variations in quality of ores, cokes, or other materials charged into the furnace will have a similar detrimental effect on economy.

A most important matter in a blast-furnace plant, as in any other kind of installation, is balance, or proportion of parts. The problem in this case is to find the golden mean between an extravagant provision for an unkonwn future and too close a cutting down to the limits of presently visible needs.

Above all, it is desirable to have plenty of space, plenty of land. A young plant should have plenty of land for its present operation and plenty more for its future growth. This is a matter of the most vital importance. One of the greatest of all the difficulties that British owners have had to contend with in their efforts to improve their plants has been the lack of sufficient land. The number of space-demanding developments that have arisen since most of our works were designed is very great, and it is wonderful that it has been possible to do so much as has been done with the space available. It is the worst of economies to stint a new enterprise in the matter of land. Land is the most necessary and the cheapest part of the plant. As a rule a new works will not be built where land is very costly, because that generally means that the neighbourhood is already overcrowded; but an old concern may have to buy land at a high price. Supposing your land costs you a thousand pounds an acre, or even five times that price, how much plant can you put upon it for a similar sum? Moreover, your land costs you little or nothing for depreciation and nothing for repairs.

### Ore Supplies.

There is no more vital problem than that of the future of our ore supplies. Without under-rating the great importance of the hematites of the north-west coast of England, especially in the Egremont district, the fact remains that the non-phosphoric ores of Great Britain are limited in quantity, and that the greater part of our production must come from the smelting of the phosphoric ironstones of Cleveland and the Midlands, and of imported ores, non-phosphoric or phosphoric. The development of a great part of the ironstones of the Midlands has been recent, and the reserves may be taken to be very large. The Cleveland district, on the other hand, has been extensively worked, although there remain large quantities of stone, which deteriorates rapidly in quality as the workings go further to the south-east. The length of life remaining to this field is problematical, but it may be larger than is generally supposed; in the first place, because it is a common experience that mines last longer than is expected, and, in the second place, because it is not improbable that means may be found in the future of successfully smelting stone that is at present thought to be too low in quality. This may come about through the use of new methods of treating the stone before it goes to the furnace, or through metallurgical processes as yet unknown; but it seems more probable that the solution will be found in an extension of the practice already existing of mixing with the native stone a proportion of richer foreign material. If an ore sufficiently high in iron and low in silica is used a few hundredweights will bring up a very inferior stone to the level of a fair Cleveland mixture.

Separation of shale and pyrites and small stone containing much dirt by means of picking belts and screens will have to be carried to the utmost economical limit.

The question of the economical result of less rigorous cleaning of the stone at the Spawood mines was recently investigated. The total tonnage of stone worked at the time was 8159 per week. This consisted of—

| | Tons. |
|---|---|
| Clean stone sent to furnaces .. .. .. | 5929 |
| Shale (large and small) sent out .. .. | 824 |
| "Sulphur," "Black Hard," &c., sent out .. | 410 |
| Shale left in the mine .. .. .. .. .. | 996 |

The effect of sending forward the 824 tons of shale now removed by screens and belts was considered. It was found that the mine would save in actual cost £27 per week, and, allowing for the equivalent of clean stone contained in the rejected material, might be further credited with £154 for the value of this material, making a total gain to the mine of £181 per week. The loss at the furnaces was reckoned at £691 per week, showing a net loss to mines and furnaces, taken as one concern, of £510 per week, or over £25,000 a year, whilst the net loss on the additional material sent out was 12s. 4d. per ton.

These figures make one consider whether it is possible to carry the cleaning of this kind of stone still farther; and whether, in dealing with other classes of ores, it might not in some cases prove economically sound to sacrifice considerable quantities of iron in improving the working condition of certain ores by screening out dust or by other, at first sight, wasteful means.

Many ores are capable of improvement by treatment either at the mines or at the furnaces, the improvement consisting of the removal of useless or objectionable matter; it is obviously preferable that the improvement should, if practicable, be made at the mines, as the cost of loading, carrying, and unloading the rejected material is thereby saved. If the treatment at the mines consists in the agglomeration of fines by briquetting, sintering, or other such processes, the product should be such that it will bear carriage without to any serious extent breaking up into fines again. But in many, probably in most, cases the cost of fuel at the mines will be such as to prevent the work from being carried out there, in which case it will have to be done at the furnaces, or, possibly, by some arrangement between firms, at a central station. If the fines are the result of crushing and separating, magnetically or otherwise, that part of the work will, of course, be done at the mines. Much of the improvement may in other cases be attained by simpler processes such as hand picking, washing, and screening. It would be very interesting if some chemist would undertake analyses of the dead-small in most of the materials that go into the blast-furnace and ascertain in which cases its removal would enrich, and in which impoverish, the residue.

It is of the greatest importance that our means of dealing with foreign ores in our ports should be improved; and, in the event of any large individual sources of ore supply becoming available, and in case our national production of iron and steel should increase upon its present relatively low figures, it may become even more important than it is now. Our facilities for quickly unloading large ore ships are very far from being all they should be, and compare very unfavourably with those that exist in such ports as, for example, Antwerp and Rotterdam. Unless they are greatly improved, we shall fall even farther behind in the race than we are at present. We may not be able to reach the standard of the American lake ports any more than we can equal the vast and homogeneous loads of the American ore railways, but until we can provide deep-water berths where large ships can lie afloat at all states of the tide, and until these berths are equipped with appliances for unloading ships with the greatest possible speed, and until the spirit of our labour is such as to enable us to reap the fruits of our expenditure on these objects, we shall have to pay high freights, and shall be thereby hampered in our efforts to make full use of some of the most important of the possible sources of our ore supply.

## Institution of Mechanical Engineers.

### THE ACTION OF CUTTING TOOLS.

The Institution of Mechanical Engineers met at Storey's-gate on Friday, April 28th, to discuss a paper giving "An Account of Some Experiments on the Action of Cutting Tools," by Professor E. G. Coker and Dr. K. C. Chakko, an abstract of which we print on page 503. Dr. Hele-Shaw, the President, took the chair.

In presenting the paper, Professor Coker said that it was the outcome of a suggestion from the Cutting Tools Research Committee, and was not really intended, originally, to take the form of a paper for discussion. It was rather a report on some preliminary experiments which had been made with the aid of polarised light to determine the stresses set up in the work and tool during cutting operations. He gave a brief explanation of the character of polarised light and of the manner in which it could be used to measure the stresses in a transparent body by taking advantage of the fact that the colour of the light passing through the body varies according to the stress. The changes of colour, combined with the extent of the transverse expansion or contraction of the material, were recorded by a special piece of apparatus which was somewhat like a lathe working on the edge of a disc of nitro-cellulose. Some of the tools were made of glass, while others were of steel. Professor Coker projected on to the screen a number of lantern slides which showed the bands of colour, indicating regions of stress in the material, and exhibited some graphs giving the quantitative stresses in the disc and the cutting tool.

At the invitation of the President, Mr. P. V. Vernon (Alfred Herbert, Coventry) opened the discussion. He suggested that Professor Coker's experiments only confirmed the impression that any engineer would get if he considered the matter, that is to say, they established the existence of compression in the material above the tool and tension below, a condition of affairs which would be prevalent whether the work was moving or merely pressing statically on the tool. Mr. Vernon asked for some particulars of the extensometer used for measuring the changes in the thickness of the stressed part of the disc, as he was rather sceptical as to the possibility of measuring to such fine limits as one millionth of an inch. He also gave some figures which bore out the experimenters' discovery that the stress in the material was not influenced by the speed at which it was removed. These figures were the results of experiments carried out some years ago on reducing bars of steel in a turret lathe. The bars were 2in. in diameter, and were reduced to 1¼in. or 1½in. at cutting speeds ranging from 107ft. to 210ft. per minute. The amount of metal removed per minute per horse-power only varied from 0.33 lb. to 0.42 lb. throughout that range of speeds. The ratio between horse-power and speed was also found to be nearly constant when using screwing dies instead of a turning tool.

Colonel R. E. B. Crompton said that he hoped to get considerable assistance from Professor Coker's report in his own investigations on the forces involved in cutting, which he was carrying out by electrical means. He agreed with Mr. Vernon that the polarised light experiments disclosed just what might be expected, and said that although he found difficulty in measuring to the ten-thousandth part of an inch, Professor Coker was evidently successful to the one-millionth part. He pointed out that the authors' tests were hardly comparable with workshop practice, as the tool was only fed into the work radially, whereas in practice the tool was fed along the work and produced forces in three dimensions, which might introduce shearing forces that would not be revealed as such by polarised light. Then, again, the steady conditions recorded during the experiments never persisted in practice, and the chip was always produced, after a very short preliminary stage, as a series of little prisms welded together on to a narrow strip that came off next to the tool. The edge of the tool itself was also greatly modified in the process of cutting steel, and Colonel Crompton had found that the power required actually decreased after a short period of cutting. Microscopic examination of the tool at this stage showed that the extreme cutting edge had been sharpened by the friction of the chip, causing the familiar "crater" on its upper face, and some photographs which were handed round the room showed this effect plainly. Colonel Crompton thus considered that if the experiments were to be of any commercial value they should be continued until the tool had settled down into the condition he described.

Sir A. Hadcock (Armstrong, Whitworth and Co.) said that the subject of the paper interested him greatly, as he had employed the polarised light system in investigating the strength of very thick cylinders when stressed beyond the elastic limit. The behaviour of these cylinders could not be reconciled with theoretical investigations, so Professor Coker's methods were tried; but he doubted if celluloid behaved like steel when under stress, and although Professor Coker's results agreed with theory, they did not go beyond the elastic limit. The effect of the tearing action of the tool in some conditions, as described in the paper, obviously left the surface of the material in a stressed condition, as it was well established that a rough-turned tension test piece would fail more readily than one finished with a smooth surface.

Mr. E. R. Dolby asked Colonel Crompton if the tool used in his experiments had been lubricated. To which Colonel Crompton replied that a lubricant was not used, as it was possible to calculate the difference in the forces between lubricated and dry conditions, while the use of a lubricant made the cutting very irregular.

Mr. F. W. Lanchester (Daimler Company) was another of the speakers who considered that the divergence from practical work represented by the experimental disc was so great that the results were not likely to be of much commercial use, and he suggested that Professor Coker might try using two tools, facing one another, with the object of eliminating end thrust, on opposite sides of the disc, and acting as parting tools; while Mr. Sears (National Physical Laboratory) commented on the extreme delicacy of measuring, as the author did, in millionths of an inch.

Mr. H. I. Brackenbury (C. A. Parsons and Co.) made a sketch on the blackboard by means of which he showed that when a heavy cut is being made in the lathe the point of the tool may be as much as one eighth of an inch distant from the actual point where the shaving begins to part from the work. He said that at a comparatively low cutting speed the chip curled up as it came off, but that as the speed was increased the curvature of the chip was reduced, until at a speed of 120ft. per minute it was almost straight, and it came off so fast as to be dangerous to the workman. He thought, however, that at the speeds Professor Coker used the tool was actually cutting in contact with the work.

In the course of his reply, Professor Coker made a rough diagram of the extensometer used in the experiments, which, he said, had been used before. It comprised two needles bearing against opposite sides of the disc. One of the needles could slide in a casing, and was connected with a system of levers that operated a mirror which was used to reflect a beam of light on to a drum of sensitised paper. The drum was rotated in unison with the experimental disc, and a curve was drawn on it by the extensometer, with the disc free, to give a datum line. Another curve was then drawn with the cutting tool in action, and the distance apart of the two curves was a measure of the extension or compression of the disc. He had made some experimental investigations on three dimension stresses, as suggested by Colonel Crompton, but had not got very far with them yet; but he thought that the tests carried out, as described in the paper, on two dimension stresses threw a lot of light on the action of three dimension stresses. Cellulose, he thought, behaved in the same manner as steel, when under stress, up to the elastic limit.

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The extension of the Bergen wireless service, for which the Storting has voted 100,000 kroner, is expected to be completed in June. The station will be equipped with both the wireless telegraph and the wireless telephone and will deal more especially with shipping. The wireless telephone will have a radius of 600 kilom., which will enable it just to reach the North of England.

## Obituary.

### WILLIAM BLOW COLLIS.

THE death is announced of Mr. William Blow Collis, of Swinford House, Stourbridge, which took place on Monday, April 24th.

Mr. Collis, who was the son of a solicitor, was born at Stourbridge in 1839. He received his early education at a private school at Kidderminster and at the Grammar School in the same town, but at the age of twelve years he went to Westminster School, at which he had gained an entrance scholarship. At the age of seventeen he entered the Woodside Ironworks at Dudley of Messrs. Cochranes, becoming afterwards under-manager of the blast-furnace. He also spent some time at the Middlesbrough works and collieries of the same firm. He was closely connected with the Granville and Gorsty colliery, which had been opened up by Mr. J. E. Swindell and his father, who died in 1858. In this connection, in collaboration with his brother, the late Mr. E. J. Collis, he took out patents for coke ovens. Later, he, with a Mr. Dawson, patented a gas-fired wagon brick kiln, which he worked with considerable success. For some time prior to 1870 he practised as a consulting engineer in partnership with the late Mr. J. J. King, and about that time started, with a few friends, a system of mine drainage which eventually developed into the South Staffordshire Mines Drainage Commission. In this connection he was responsible for the re-modelling and setting to work of some old engines, and for the design and erection of new pumping machinery, particularly of the large engine at Waterfall Lane. He was also instrumental in preserving an original Newcomen engine which, we understand, is still used as a stand-by at the Windmill End pumping station.

Mr. Collis was a mining engineer of considerable repute, particularly in the South Staffordshire district, and his expert advice was constantly being sought in connection with mining questions. He was chairman for many years of the Cannock Lodge Colliery Company, Limited, and for thirty years managed the Homer Hill Colliery for Messrs. Samuel Evers and Sons. He was chairman for some time of the Wordsley Brewery Company, as well as of the Stourbridge Water Company, of which he was a director for forty years. Of the local Gas Company, too, he was a director for twenty-five years. Of the Stourbridge Navigation he was a director for forty-six years and chairman for twenty-three years. He also served on the Midland Coal Trade Wages Board, and was a member of Council of the Midland Institute of Mining Engineers.

## National Foundry Competition.

A NATIONAL foundry competition is to take place in connection with the International Foundry Exhibition, which will be held at Bingley Hall, Birmingham, from June 15th to 24th next. Both exhibition and competition are being organised conjointly by the Birmingham Chamber of Commerce, the Institution of British Foundrymen, and the British Cast Iron Research Association.

The competition will be open to all foundry employees, ex-Service trainees, and technical school students in Great Britain under twenty-one years of age on May 15th, 1922—except in Class C—male or female, whether in employment or not. Neatness, finish, initiative and time taken in the work will be the basis of awards. The competition will be divided into three classes, A, B and C, which will, in turn, be subdivided.

*Class A.*—For making the best core in one of the following sections:—Section 1: For light castings. A radiator core; a water-cooled cylinder core (oil sand core). First prize, £3 3s. and second prize £2 2s., both presented by the National Light Castings Association. Section 2: For medium castings. A pipe work core; an arm core and tooth core for wheel. First prize £3 3s. and second prize £2 2s., both presented by the President, the Right Hon. Lord Weir. Section 3: For heavy castings. A steam port core for cylinders or pumps; a strickled core. First prize £3 3s. and second prize £2 2s., both presented by the British Engineers' Association. The winner of the first prize in each section will also receive a diploma from the Birmingham Chamber of Commerce. A consolation prize of a foundry technical book will be given for the entire class.

*Class B.*—For making the best mould in each of the following sections:—Section 1; Floor moulding. First prize £5 5s., second prize £3 3s., and third prize £2 2s., all presented by Lord Weir. Section 2: Two-part work moulding. First prize £5 5s., second prize £3 3s., and third prize £2 2s., all presented by the Worshipful Company of Founders. Section 3: Three-part work moulding. First prize £5 5s., second prize £3 3s., and third prize £2 2s., all presented by the Institution of British Foundrymen. The winner of the first prize in each section will also receive a diploma from the Birmingham Chamber of Commerce. A consolation prize of a foundry technical book will be given for the entire class.

*Class C.*—For making the best pattern to a blue print design to be supplied to each competitor. The pattern to be made in best yellow pine at competitor's shop, works or school. Section 1: Open to all over twenty-one years of age. First prize £5 5s., presented by Mr. H. Lakin-Smith, F.C.A.; second prize £3 3s., presented by Mr. J. E. Fletcher, M.I. Mech. E.; third prize £2 2s., presented by Mr. H. L. Reason, M.I. Mech. E.; and fourth prize £1 1s., presented by Mr. Thos. Vickers. Section 2: Open to all under twenty-one years of age. First prize £5 5s., presented by the proprietors of the *Foundry Trade Journal*; second prize £3 3s., presented by Mr. H. Field, President, Birmingham Branch, I.B.F.; and third prize £2 2s., presented by the proprietors of the *Foundry*. Section 3: Open to students at any technical school in Birmingham and in a radius of 10 miles from Birmingham, under twenty-one years of age. First prize £3 3s., presented by Mr. W. Waters Butler; and second prize £1 1s., presented by Mr. Thos. Vickers. The winner of the first prize in each section will also receive a diploma from the Birmingham Chamber of Commerce. A consolation prize of a foundry technical book will be given for the entire class.

Further particulars and information regarding the general conditions attaching to the competition may be obtained on application to Mr. Thos. Vickers, honorary secretary, Technical Advisory Committee, Central House, 75, New-street, Birmingham. It may be added that the entries close on May 15th, and that there are no entrance fees.

## THE RELATION OF THE ELEMENTS.

PROFESSOR SIR ERNEST RUTHERFORD, F.R.S., delivered the twelfth annual May Lecture to a meeting of members of the Institute of Metals on Wednesday last, at the Institution of Mechanical Engineers, Westminster. He said that very rapid strides in the growth of our knowledge of the constitution and relation of the elements had been made in the past decade. It had become clear that the atoms were electrical structures of the same general type, consisting of a minute but massive charged nucleus surrounded at a distance by a distribution of negative electrons. The work of Moseley had shown that an unexpectedly simple relation existed between the elements. Apart from its mass, the properties of an element were defined by a whole number, which represented the charge on the nucleus and the number of the outer electrons. This number also gave the ordinal or atomic number of the element arranged in order of increasing weight. All the known elements were defined by numbers starting from 1 for hydrogen and ending at 92 for uranium, and only a few numbers were missing. The discussion of the structure divided itself into two parts, one the laws controlling the position and movements of the outer electrons, and the other the constitution of the nucleus. After reference to the recent remarkable theories of Bohr to explain the distribution and motion of the electrons and the origin of the periodic variation of the properties of the elements, attention was directed to the structure of the nucleus which was of great complexity in heavy elements. The evidence derived from a study of the disintegration of the radio-active elements showed that the nucleus contained both helium nuclei and electrons, but no sign of the emission of hydrogen nuclei had been observed. The atoms of the elements were very stable structures, and in order to break them up it was necessary to use concentrated sources of energy to overcome the powerful forces holding the nuclei together. The most suitable agent for attack was the swift alpha particle from radium. The atoms were bombarded by a stream of alpha particles and occasionally one of the latter passed close enough to a nucleus to effect its disruption. Experiments made by DR. Chadwick and the speaker showed that in this way swift hydrogen nuclei were liberated from the atoms of nitrogen, fluorine, sodium, phosphorus and aluminium, but the amount of disintegration was on a very minute scale. It seemed clear that hydrogen nuclei were constituents of the nuclei of these atoms, and were in all probability satellites of the main system. It was believed that the helium nucleus was a secondary structure built up of four hydrogen nuclei, and that consequently the nuclei of all elements consisted ultimately of an ordered structure of hydrogen nuclei and electrons. The arrangement of the parts composing the nucleus and the forces operative were quite unknown, and the difficulties of direct attack on this problem of nucleus structure were very great.

## PHOTOGRAPHIC SURVEYING.

THE accuracy of a photographic map depends first of all on the precision of the triangulation system controlling the survey. After that it is dependent on the number of camera stations and on the scale of the plan. Any scale or contour interval may be used. For general purposes a contour interval of 100ft. and a scale of 1:40,000 are, according to an article by Mr. M. P. Bridgland in the *Canadian Engineer*, very convenient for a large plan. The precision is that of a good plane table survey, but with the advantage that many more points are plotted and the contouring is done by the surveyor in the office, with views from different stations continually before him, while with a plane table this comparison is entirely wanting.

The most tedious and tiresome part of the work is plotting the points and drawing the contours. The office work requires at least twice as long as the field work. However, the time required for the field work, which is the most expensive, is much less than if any other method of survey were employed, and consequently delays due to adverse conditions are reduced to a minimum. The office work is carried on by a small staff and under favourable conditions, and is not so subject to unexpected interruptions.

A party of seven can work to good advantage under most circumstances. The party consists of the surveyor, his assistant, and five men; two of them should be expert packers, if pack horses are used. With two sets of instruments, the surveyor and assistant surveyor, each accompanied by two men, are free to work in different localities, the cook being left in charge of the camp at some central point. Except on long or dangerous trips one man is enough to accompany the surveyor when actually climbing. In a country unusually difficult of access, extra help may be necessary, and even under ordinary circumstances an extra man is often an advantage.

With regard to the future of photographic surveying, it is probable that owing to the nature of the country to which it is applicable, the demand for work of this kind will always be rather limited. There are very large mountainous areas in Alberta and British Columbia which can be satisfactorily mapped in this way, and other less broken areas, some partially timbered, which may be mapped by the camera alone or by the camera used in conjunction with other methods. While this class of country will not develop with a rush, as the prairie did a few years ago, its development will be gradual, and there will be an increasing demand for topographic maps until ultimately it will all have to be surveyed. So far the work has been confined to Government surveys of large areas on a small scale, but it is probable that as the method becomes better known, it may be found a rapid and accurate means of obtaining the topography of small broken sections on a large scale. Should such be the case, its field of usefulness would be greatly extended.

## Letters to the Editor.

*(We do not hold ourselves responsible for the opinions of our correspondents.)*

### A NEW TYPE OF REINFORCED CONCRETE PIPE JOINT.

SIR,—The article in your current issue is of great interest to all hydraulic engineers. When this joint was first mentioned in the American papers the writer considered that the expense due to the machined cast iron ends would make the reinforced concrete pipe nearly as costly as a metal pipe. There is also the difficulty mentioned in the article of making sound joints between these cast iron ends and the body of the pipe. Even in making ordinary reinforced concrete pipes in long lengths there is very great difficulty in procuring pipes free from cracks and voids due to the concrete clinging to the reinforcing bars and not settling down solid in its place. If such pipes are cast in the ordinary way on end it is essential that, say, half-a-dozen should be constructed at a time and a few inches only of concrete deposited in each in rotation and thoroughly compacted, and the process repeated till the whole of the pipes are finished. It is also advisable to have the aggregate under ¼in. in diameter.

British engineers would probably prefer a plain-ended pipe with an adjustable joint of the collar type, such as the double-gland joint. The writer believes, however, that a joint made with hard caulked neat cement in a reinforced concrete collar will be quite serviceable for moderate pressures, and that such joints have not had a fair trial yet.

April 19th. WATER ENGINEER.

### ORGANISATION AND WAGES.

SIR,—A careful perusal of the letters in recent issues, dealing with the subject named above, combined with a more than cursory study of your leading article on the cognate subjects of "Science and Labour"—THE ENGINEER, April 7th—proves that many are qualified to criticise and therefore to condemn (?) existing systems, prevailing methods and their results.

To a limited extent, this destructive criticism is necessary and useful. Until the defects and shortcomings of men, machines or economic systems are listed and tabled, it is vain to expect reform or amendment, but the affection for times that are past and conditions never likely to recur may easily become an obsession and a hindrance to progress.

Old Joe Willet objected to coaches; Samuel Weller, the elder, detested locomotives; and the Luddites protested with energy and warmth against the introduction of "the devil's tools"; and now your pages record emphatic protests against further steps in the development of the industrial system.

Modern conditions produced this system—the large works, trade combinations, huge aggregations of employees directed and controlled from one centre, with the inevitable tendency for these aggregations to increase, to expand, alike in industrial, commercial and financial groups.

To spend time and energy lamenting the "passing away" of the small works and factories, where the foreman was a variety of super-man, capable of tackling any job that came along, and successfully dealing with it, is absolute waste. "There ain't no such person" to-day, and many of us question if he ever existed, while the small factory appears to be nearing the state of the political nostrum, described by Disraeli as not only dead, but damned!

That being the case, the "Big Business" being here, and here to stay for a time apparently, is it worth while to spend time criticising the trivialities of minute details of the records connected with the routine followed in some particular factory, where it had been probably introduced, wilfully and of malice aforethought, by some of the friends of the old foreman?

Systematic planning, recording, routing, following up, checking, testing—all these are considered necessary in a big factory. Can anyone offer a substitute?

Birmingham, April 29th. A. WILLIAMS PRICE.

### LOCOMOTIVE COUNTERBALANCING.

SIR,—Adverting to the query as to whether the Agenoria of 1829 had wooden or metal wheels, I have now ascertained that the engine had cast iron wheels with wrought iron tires. The question concerning the balance weights, however, is not cleared up by that fact, and it seems difficult definitely to decide when they were fitted to the engine. The Stourbridge Lion, a very similar locomotive completed by the same builders—Foster, Rastrick and Co.—in 1838, certainly had no such weights. It is noteworthy that each of these engines had a steam dome, a fact that is sometimes overlooked, as the first British-built locomotive to be provided with that appendage is generally taken to be Hackworth's Globe, constructed for the Stockton and Darlington Railway in 1830. The dome was placed at the rear end of the boiler in the case of the Agenoria, but in the case of the Stourbridge Lion it was either at the front or in the middle. Different drawings show the two different positions, thus affording another instance of the difficulties which beset the path of the historian and the seeker after truth.

Stevenage, Herts, April 29th. F. W. BREWER.

### ERRATUM.

AVOIDABLE WASTE IN LOCOMOTIVE OPERATION.—Correction to letter, page 477: To "Note," on eleventh line from foot of column 1, substitute "decreases" for word "increases."

C. R. K.

# A Seven-Day Journal.

## A New Atlantic Record.

ON the return portion of her second trip since being converted for oil fuel firing, the Mauretania easily surpassed the average speed which she maintained on her first trip. She arrived at Southampton on Monday morning five days eight hours fifty-six minutes after leaving New York. Her average speed was 25.14 knots. For a short time on the day before her arrival in port her speed touched 27.5 knots. She thus has not only accomplished the fastest Transatlantic crossing since the war, but broke her own and therefore the world's liner speed record.

## Gift to the British Association.

THE general treasurer to the British Association for the Advancement of Science has announced that the Hon. Sir Charles Parsons has placed unreservedly at the disposal of the Council of that body a gift of £10,000 Five per Cent. War Loan Stock. This generous action on the part of Sir Charles should prove of great benefit to the Association by removing the possible chance, hitherto existing, of its activities being restricted through the depletion which its resources have suffered during the past seven years. Since its foundation in 1831 the Association has made grants in aid of scientific research totalling more than £83,000. At last year's meeting in Edinburgh the grants voted reached about £500, but there is no doubt that the Association could advantageously administer a larger sum. Whether the interest on Sir Charles' gift will so be expended will be decided at the next Council meeting in June. If such destination be determined for it, the exact branches of research to be benefited would probably be settled at the annual meeting at Hull in September.

## Woolwich and the Government.

THE claims of the Arsenal and Dockyard at Woolwich for increased consideration on the part of the Government are once again being strongly urged by those interested in the borough's welfare. It is pointed out that before the war the Government establishments at Woolwich employed 14,461 workpeople. By the date of the Armistice this number had been increased to 102,486. On September 26th last the workpeople numbered 17,096, while on March 31st this year they amounted to 15,965. If the reduction is continued, it is argued, a point will soon be reached at which the staff left will be insufficient to serve as a nucleus should expansion again become necessary. A greater share than at present, it is advocated, should be given to the Arsenal of armament and other Government work, the suggestion being that firms deprived of such work for the benefit of Woolwich could find alternative employment on private orders such as the Arsenal cannot accept.

## The Imperial Airship Scheme.

THE scheme for the establishment of a commercial airship service between Britain, India and Australia advanced by Commander C. D. Burney with the support of Vickers and the Shell oil group has received the approval of the Federation of British Industries. In a letter to Captain Guest, Minister for Air, the Federation states that it has carefully examined the scheme, and has come to the conclusion that every effort ought to be made to give it effect provided the Air Ministry considers the financial estimates reasonable and the service practicable. The Federation adopts the view that real benefit from air transport will not accrue to the commercial community until the long-distance routes, such as that covered by Commander Burney's scheme are opened up. The financial estimates embodied in the scheme as originally outlined have been modified so as to reduce the required contribution from the Treasury. It is fully expected that the Air Ministry will now recommend the Government to afford the necessary assistance.

## A New Air Route and a New Air Record.

NEXT Monday, when the King and Queen travel to Belgium, the Royal yacht will be accompanied on its voyage by an aeroplane, the first to operate on the Croydon-Brussels air route in connection with the Instone Air Line's new service. The machines to be employed are ten-seaters, and will perform the single journey in 2¼ hours. The Instone Air Line has been appointed by the Air Ministry the sole subsidised undertaking on the Brussels route. On the London-Paris service a record was established on Monday by Captain E. D. C. Herne, in that, using the new DH 34 machine, he made four successive single trips between the two capitals in the interval from 6.55 a.m. and 5.40 p.m. Out of the 10¾ hours between his first ascent and his last descent he spent 8 hours 52 minutes actually in the air. The total distance covered was approximately 1000 miles.

## The Shipyard Strike.

THE exact terms agreed to between the shipbuilding employers and the Unions' Negotiating Committee in connection with the dispute over the discontinuance of the war bonus were revealed soon after we went to press last week. They comprised a reduction of 10s. 6d. per week on and from March 29th, and two further reductions, each of 3s. per week, on and from May 17th and June 7th. Some trouble, it seems, was experienced in inducing the representative conference of the unions to approve of these terms, but ultimately it was agreed to submit them to the ballot of the members with the recommendation that they should be accepted. The balloting began on Saturday, and continued up to Wednesday night, but so far the result has not been announced.

## Dundee and the Grampian Hydro-electric Scheme.

THE opposition of Dundee to the Hydro-electric Development Company's Grampian scheme, the Bill in connection with which went into Committee on the 2nd inst., has now apparently been withdrawn. At one time it was proposed by the Dundee Electricity Committee that an arrangement should be entered into with the company provided the price charged for the energy were reduced to £3 per annum per kilowatt of maximum demand and 0.2d. per unit, and provided the company paid the standing charges and a fixed annual rental of £5000 in respect of the Corporation's electricity station. The Town Council, however, has now decided to withdraw its opposition to the Bill, provided the company will not run its cable through Dundee and will withhold permission for electrical construction work other than for main line railway electrification.

## Stainless Steel American Patents.

THE patent rights for stainless steel in America are owned by the American Stainless Steel Company, of which firm Mr. Harry Brearley is a director. The American Company recently instituted proceedings in the United States courts against the Ludlum Steel Company, of Watervliet, N.Y., with the object of preventing it from making and selling steel which, it was alleged, infringed the patents held by the American company. The case was regarded as being of great importance, in that it was the first test of the validity of the rights claimed in the American company's patents. Judgment, we learn, has now been awarded in favour of the Ludlum Company on the ground that its mixture or formula was different from that used in making stainless steel in accordance with the patents held by the American company. An appeal against this decision will, we gather, probably be lodged.

## Hydro-electric Development at Elswick.

IN May, 1920, a hydro-electric section was formed as part of the civil engineering department at the Elswick works of Armstrong, Whitworth, the immediate object of which was to manufacture water turbines to the designs of a Norwegian firm. The development of the work of this section has now called for its separation from the civil engineering department and its elevation into a department of its own. The new department is charged with the duty of dealing with complete water-power development schemes in all aspects, civil, mechanical, and electrical. The firm is working in this matter in conjunction with a powerful London financial group, and has at present in many parts of the world survey parties at work investigating various projects which have been brought to its notice. The offices of the new department are at 8, Great George-street, S.W. 1, and the management is in the hands of Mr. Douglas Spencer, assisted by Mr. Robert P. Tod, Mr. V. Bataillard, and other hydro-electric engineers.

## The Immunity of Public Ships.

SINCE the King can do no wrong, it follows in law that the King's ships are above the ordinary procedure in the matter of recovering damages for collisions caused by them or of claiming for salvage or towage services rendered to them. By extension, this principle is applied not only to warships, but to State-owned vessels engaged on ordinary commercial duties and to private vessels hired by the State for trading purposes. By farther extension, the immunity from legal proceedings also applies to vessels owned by or in the employ of foreign sovereign States. Any compensation that may be secured for loss, damage, or services is awarded as an act of grace. State-owned vessels are above the necessity for obeying such safety regulations as those relating to the load line, deck cargoes, &c. Shipbuilders, repairers and dry dock authorities have no right of suit against a sovereign State in connection with a State-owned vessel. Dock, harbour and river conservancy authorities, underwriters, bankers, merchants, passengers, and crew are equally at a disadvantage. The position has been aggravated since the war by virtue of the increase in the number of State-owned vessels engaged in trade. It is, in fact, regarded by the Chamber of Shipping of the United Kingdom as fraught with danger to the welfare of international overseas trade. At the instance of the Chamber, the subject will be made the chief item on the agenda at the conference of the Comité Maritime International, to be held in London in October. It may be added that under the terms of the Versailles Treaty Germany agreed to accept in this matter the status of an ordinary litigant and not that of a sovereign State.

## London-Manchester Underground Telephone Cable.

THE new underground telephone cable between London and Manchester, opened on the 27th, marks an important stage in the development of telephony in this country by reason of the fact that it is equipped with thermionic valves, instead of relays, for repeating and amplifying the currents. The cable is at present working on a temporary repeater station at Leicester, but will eventually have two such stations, one at Fenny Stratford and the other at Derby. It contains 320 copper wires which provide 156 telephone speaking circuits, together with a certain number of telegraph circuits. A similar cable between London and Birmingham, and from thence to Liverpool, will soon be available. The ultimate plans of the Post Office contemplate underground telephone cables radiating from London to Cornwall, Southampton, Dover, Norwich, Hull, Newcastle, Edinburgh, Glasgow, Manchester, and Swansea.

## Pisa and a Monument to Galileo.

REPEATED proposals over a period of many years have been made to erect in Pisa a fitting monument to Galileo, the celebrated astronomer and physicist, who was born in the town in the middle of the sixteenth century. Schemes to this end were advanced in 1864, 1888 and 1900, but either through lack of support, the death of those interested in the collection of the money, or the failure of the bank with which it was deposited, they all withered away to nothing, until the whole matter became something of a joke. The Archbishop of Pisa, Cardinal Maffi, himself an able scientist and at one time Director of the Astronomical Observatory at Pavia, has now revived interest in the matter by proposing to erect the suggested monument at his own expense. Strong opposition to his scheme is, however, being expressed on the ground that the Church, having, through the Inquisition, persecuted Galileo, was debarred from erecting a monument in his honour. It is possible that the opposition of the Pisans to the Cardinal's scheme is tinctured with remembrance of the fact that he it was who some years ago showed that neither the house in which Galileo was alleged to have been born nor the lamp in the Cathedral, the swinging of which was said to have induced the philosopher to investigate the action of the pendulum, could possibly have been in existence in his time.

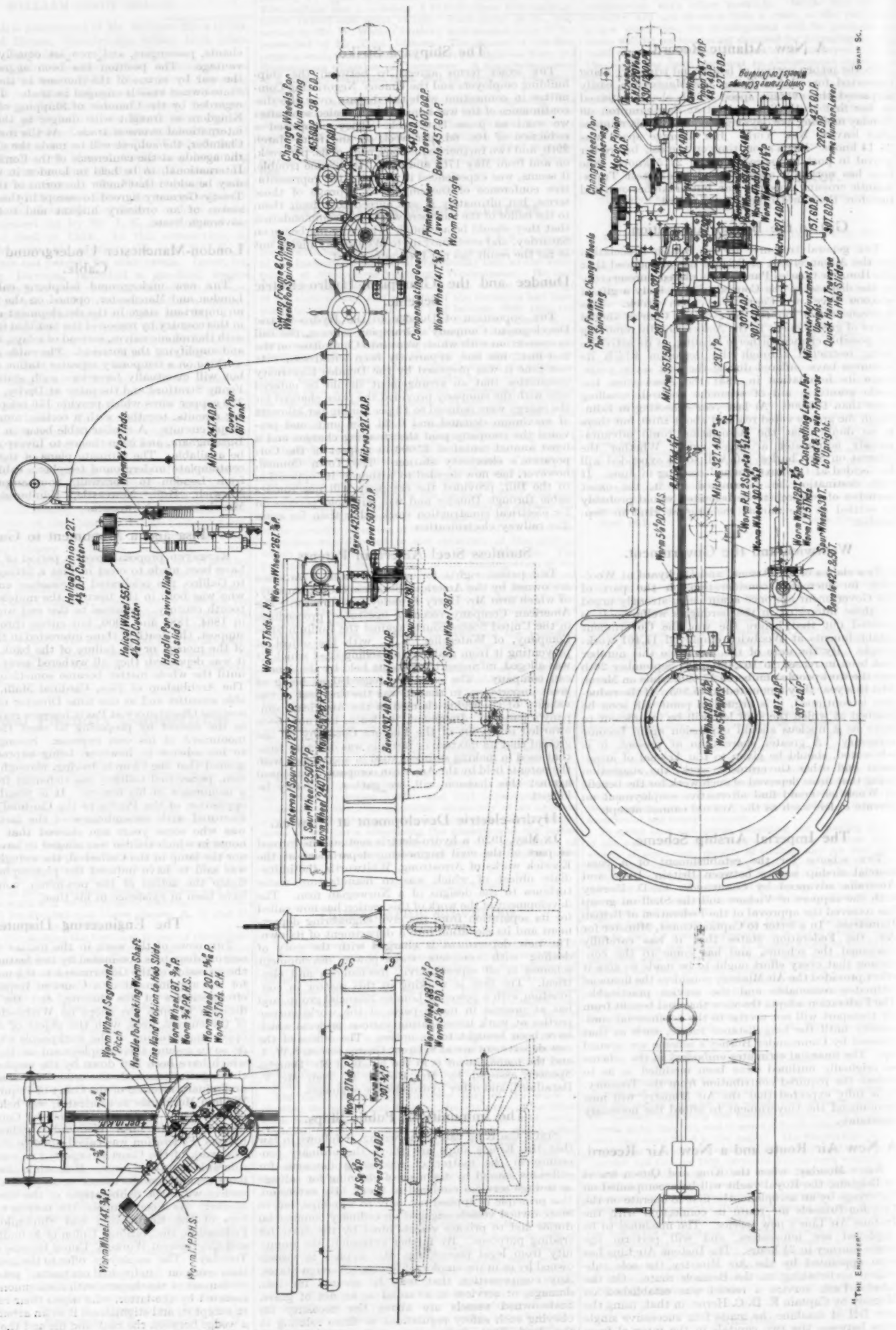
## The Engineering Dispute.

THE news of the week in the matter of the engineering dispute is dominated by two features, namely, the accession of the Government to the men's request for the appointment of a Court of Inquiry into the circumstances of the dispute, and the employers' decision to open the shops on Wednesday morning of the current week with the object of affording an opportunity to any of the workpeople who desired to do so to resume their employment on the conditions which have been laid down by the employers during the negotiations with the union representatives. A preliminary meeting of the Court of Inquiry, with Sir William Mackenzie as arbitrator, was held on Friday of last week. The real work of the Court did not, however, begin until Wednesday, when the Employers' Federation was called upon to state its case. The work of the Court is expected to occupy a considerable length of time. Meanwhile the employers have decided not to cancel or suspend the lock-out notices while the deliberations of the Court are proceeding. As a consequence, the notices to the members of the Engineering and Shipbuilding Trades Federation, the National Union of Foundry Workers, and the General Workers' Union became effective on Tuesday. The employers' offer to the men to resume their work on "individual contracts," pending a final settlement of the dispute with their unions, was hotly resented by the latter, who urged their members not to accept it, and stigmatised it as an attempt to drive a wedge between the rank and file and the Executive. Latest reports from the engineering centres indicate that while in some districts, such as Manchester and Glasgow, no response has been made to the employers' offer, in others, such as Birmingham and Liverpool, a fair number of men applied for work.

# MACHINE FOR CUTTING TURBINE REDUCING GEAR WHEELS

W. MUIR AND CO., LIMITED, MANCHESTER, ENGINEERS

(For description see opposite page)


Change Wheels For Prime Numbers
Swing Frame & Change Wheels for Spiralling
Prime Number Lever
Worm R.H. Single
Compensating Gears
Mitres 327.4 D.P.
Cover for Oil Tank
Handle for swivelling Hob slide
Worm Wheel 267 D.P.
Spur Wheel 387.
Worm Wheel 287 D.P.
Worm R.H. Single
Mitres 357.5 D.P.
Controlling Lever for Hand & Power Traverse to Upright.
Quick Hand Traverse to Hob Slide
Worm Wheel 287 D.P.
Worm 5 1/2 D.P. R.H.S.
Spur Wheels 387.
Bevels 427.8 D.P.
Worm Wheel 267 D.P.
Worm 5 Thds. L.H.
Worm Wheel 147 3/4 D.P.
Worm 3/4 D.P. R.H.S.
Worm Wheel 207 3/4 D.P.
Worm 5 Thds. R.H.
Worm 1 D.P. R.H.S.
Worm Wheel 287 1/4 D.P.
Worm 5 3/8 D.P. R.H.S.
Worm 27 Thds. R.H.
Mitres 327.4 D.P.
Swan Sc.

# Turbine Reduction Gearing and its Production.*

THE outstanding requirement of turbine reduction gears is silent and smooth running. To achieve this result, great accuracy in the cutting of the teeth is required. It is also obvious that the more gradually the teeth come into contact, the smoother the running; hence the adoption of the helical type of tooth. The design of a machine tool to handle such work should meet the following requirements, A, B, C, D, E, F and G:—

(A) A dividing wheel of maximum diameter should be available properly to control the work; the larger the dividing wheel the better the results.

(B) A very accurate dividing wheel is imperative.

(C) The mechanism controlling the spiral angle must be so arranged that the tooth angles of mating gears are automatically produced with the absolute identical angle, without recalculating or resetting the spiral change gears. Though all the mechanisms in the machine illustrated on pages 494 and 498 are under the control of a single drive and are interdependent, they may be considered as three motions having independent functions:—The hob motion which can be varied through a differential mechanism; the table motion, which can be varied by the main dividing change wheels; and the down traverse of the hob slide, varied by its feed gears. The elements of the mechanisms will be understood from the following notes and a reference to the diagram below. In this, A is the hob driven through shaft D by change wheels E from the motor. B is the dividing wheel driven by worm C through shaft and change wheels G G¹ from motor. The gears E and G, of course, vary with the different numbers of teeth to be cut. The feed screw L is controlled by the shaft D through feed gears H—four changes—worm and wheel J and compensating gears K through a shaft which also controls the accelerating or retarding of the hob through change gears M and differential gears N in order to produce the various right and left-hand spiral angles in the teeth. It will be noted that differential control of the spiral angles is the hob motion section. The spiral angle could be obtained by placing the differential gear in the table motion shaft, but this arrangement upsets the requirement (C), because change wheels have to be introduced, which sometimes preclude identical angles being obtained in the mating gears, thus affecting the continuous bedding of the teeth.

(D) In fast-running gears with heavy tooth pressures the principle of the hunting tooth should be adopted. This often demands the introduction of a prime number in the teeth, consequently a mechanism for automatically dividing for prime numbers is called for. To meet this requirement, Messrs. Muir developed and patented a prime number dividing mechanism, which is embodied in the gear box, as follows:—From the table drive shaft, through a reversing bevel drive and change wheels P, a supplementary differential gear Q is introduced into the hob drive D. By this means the change wheels P can add to or subtract 1, 2, 3, 4 or 5 from the number of teeth the gears G would produce.

(E) The machine once started cutting is often required to run night and day for two or three weeks without stopping, in order to eliminate casual variations. The design and arrangement of gears to meet this requirement has demanded the most careful consideration. They are of cut steel, hardened, running in lubricant in a box provided with inspection doors, carried at end of the bed, see page 494.

(F) As the work varies in weight from comparatively light pinions to gear blanks weighing 30 tons, the friction set up in rotation of the heavier gears has to be partially relieved to give a reasonably constant torque. To achieve this, an easily adjusted counterpoise is required. The balancing arrangement shown efficiently meets this requirement.

(G) The position of the worm controlling the dividing wheel, with regard to that of the hob, is important. If the work is placed at the opposite diameter to the job working through the dividing wheel, distortion is liable to be set up. The work should be placed, if possible, vertically underneath the hob. By so doing the distortion factor is entirely eliminated.

## DESCRIPTION OF MACHINE.

The general arrangement of the machine is shown on pages 494 and 498, from which it will be noted that the bed is of the banjo formation to accommodate the interchangeable tables. The circular end carries a massive hollow spindle on which the table pivots. The hole in the table spindle is 2ft. diameter, and as some gear blanks are mounted on their shafts before the cutting operation, this permits the shafts to pass through the bed, bringing the blank into a convenient position on the table for cutting. The lower end of this hollow spindle rests on a footstep ball race carried on a fulcrumed weighbridge arrangement, to which is connected an outside steelyard arm, by which any counterpoise to the weight carried by the spindle up to 30 tons can be given and indicated by the floating steelyard. To the other end of the bed is attached the gear-box containing all the driving mechanism. This gear is all closed in and running in lubricant, distributed to the required parts by means of a pressure pump. This supply of lubricant is entirely separate from the cutting compound which is spread on the hob, which lubricant, after being used, passes through a sieve into a tank in the base, whence it is pumped into a reservoir, giving a gravity feed supply to the hob.

Apart from the ability to run continuously for long periods, absolute rigidity is called for, especially in the large gears dealt with. The massive design of the upright will be noted. It can be run along the bed to or from the work by quick power. At the same time, by means of ball race bearings, it is easily adjusted by hand—that is, when dealing with the depth of cut. The hob is brought to touch the blank—the micrometer disc set to zero—then from this setting all information regarding the important question of the depth of tooth is clearly indicated.

The spindle slide carrying the hob is mounted on the face of the upright, and is very carefully designed so as to give even motion without chatter. The guide for the down traverse has internal narrow angles for steady motion, and outside strips for stability. The down traverse referred to is under the control of a very accurate screw, which is equally important to that of the dividing wheel, because a combination of the two gives the angle of the tooth spiral, and any appreciable variation affects the even bedding of the teeth. The thread of the hob tooth must always lie exactly in the line of the tooth space of the helix, and may be either left or right hand; consequently, the slide carrying the hob must be capable of swivelling to any angle on either side of the vertical. This is a most important setting because any inaccuracy affects the width of space. For this purpose, Messrs. Muir have developed a very efficient angle-finding clinometer. With this instrument the hob can be set easily and accurately to one minute of a degree, giving the correct angle of the hob to the work, independent of the levels of the machine. It is provided with a calibrating spirit level, by which a datum level can be taken from the work or bed. After this adjustment, the arm is moved through the required angle, the exact setting being under the control of a vernier scale and adjusting screws. The instrument is then placed on the hob spindle, and the slide rotated till the spirit level is horizontal.

Experience has shown that the ordinary type of hob originally used in these machines fell very far short of producing the results demanded. There was no control over the distortion set up during the process of hardening, and no responsibility could be taken for "drunkenness" of the thread, which shows itself in the rotation of the hob, thus producing an abnormal space. Further, as the distortion of the right-hand hob could not be guaranteed the same as the left-hand hob, there was no certainty that the tooth space of one-half of the wheel would be exactly the same as the tooth space of the other half. It is well known that in helical cutting the hob enters the work endways; consequently, the end threads must be tapered off like a tap to distribute the cutting, but for all that, the leading teeth do the bulk of the work in removing the metal.

The inefficiency as a routing cutter noticed in the old type of hob was greatly accentuated during long periods of cutting, and undoubtedly set up strains in the blanks which introduced inaccuracies. This led the author to develop the hob with the tooth formation as shown above. It has alternate teeth removed, permitting the hob to be ground all over to ensure correctness of shape and pitch. Another feature of this type of hob is important. Owing to its formation, the leading teeth can be given front rake so as to rout freely, thus reducing the strains referred to, and greatly increasing the resultant accuracy. The increase of distance between the cutting edges of the teeth in the hob gives the opportunity of a proper bite. At the same time, the extra space is an advantage in clearance to carry away the chips. The teeth of the hob which generate the tooth curve can also be ground with side rake, which, in cutting some materials, is of great advantage. The taper end of a hob for helical gears is at first glance apparently a paradox, and often leads to a blunder, the taper being at the back end as regards the hand of thread and direction of rotation; that is, opposite to that of a hob for cutting worm wheels. Theoretically a hob will cut either hand of spiral, but in practice, owing to the accumulated wear in the main worm, slight errors are liable to enter; consequently a right-hand hob for a right-hand spiral and left-hand hob for a left-hand spiral are imperative.

## IMPORTANT FACTORS IN GOOD PRODUCTION.

In the production of turbine gears there is more than one source from which errors can enter; consequently, the ultimate good running of the same is the outcome of many important precautions. The setting of the work is most important. Cutting should not be commenced till the surface of the blank is mounted truly concentric. Mounting of the work on a cradle is to be recommended, because bolts and cramps, passing directly through to the table, are liable to set up distortion. Further, by means of a tool box fixed on the spindle slide, the spotting surface of the cradles can be lightly skimmed up true to the rotation.

In preparing the blanks a spotting diameter should always be provided that is truly concentric to the axis of the blank, to fit which the cradle is prepared as described above.

The clock indicator at this point is a critical test of good turning, because if the sides and face are not square or the blank oval, the fault will be shown up, and should be corrected or it is risky to proceed. Foremen have been known to take days at this operation, but the splendid results have justified the trouble taken.

Another important factor that requires intelligent attention is wear in the main driving work. The material of the worm should abrade or wear rather than that of the dividing wheel itself. It is quite a simple matter to renew the worm and clear off all dividing troubles, but errors introduced into the dividing wheel are always present, and can only be remedied by a replacement. The wear referred to is remarkably small during the process of cutting-in one wheel, and has no measurable effect in the resulting tooth angle that would affect the continuous bedding of the teeth of the gears. As a matter of fact, after the first test wheel is cut the worm settles down, and the wear becomes normal, continuing in constant work cutting scores of large gears, and it is often a matter of two or three years before the accumulated error renders it necessary to replace the work.

The machines are fitted with a weighbridge counterpoising arrangement, with which a counterbalance can be interposed to relieve the weight of the work. This is adjusted till the ammeter in circuit shows that about 5 brake horse-power is being absorbed in running the machine idle. This ensures that the table is rotating safely on its bed, but with a minimum known pressure to set up friction. The ammeter provides a good gauge that the operator can keep his eye upon to warn him of variations, and the handy adjustment of the steelyard balance enables him to compensate for any alterations that may be required.

Some gears are of a weight beyond the 30 tons capacity of the weighbridge arrangement. Such weights have to be dealt with as a special case.

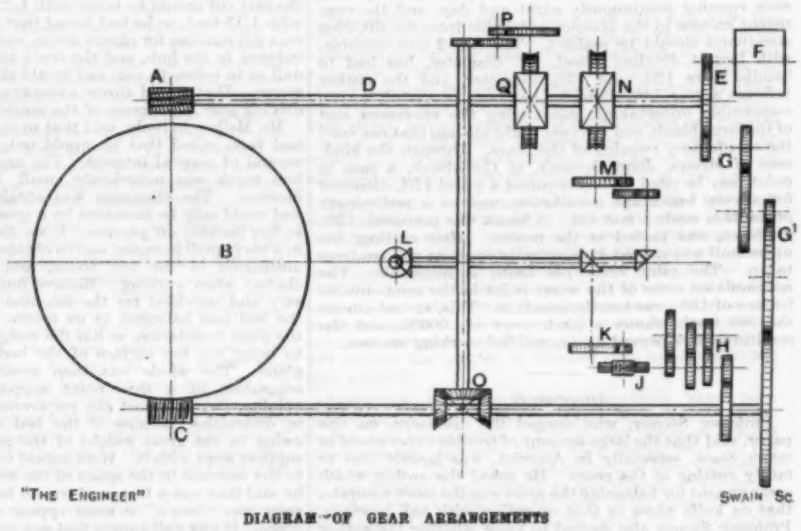
As might be expected, gears of great weight have the effect of upsetting the alignments of the machine by causing the foundations to sink, thus upsetting another very important factor in the correct cutting of the gears.

If proper precautions are taken when a machine is first set down, the readjustment of the alignment of the machine is not a serious matter. When installing, before levelling, the bed should be balanced on a flat bar, say, 6in. wide by 1in. thick. This supports the centre of gravity of the machine. Wedges are then inserted all round to bring the top surface of the bed level, and the whole grouted in. If anything arises to make readjustment necessary, the wedges are knocked out, the bed again balanced on the flat bar referred to, the wedges readjusted to bring up to level, and when grouted in again, the machine is as true as when originally set down.

Where there is a big demand for these gears, experience has taught that a separate small machine for dealing with pinions is more economical than cutting them on the big machines referred to. This machine is illustrated on page 498, and the design of the gearing is so arranged that the angle produced in the wheel on the large machine is identically reproduced in the pinion on the small machine.

Many people seem to think that a satisfactory dividing

HOB FOR HELICAL GEAR CUTTING




"THE ENGINEER" SWAIN Sc

DIAGRAM OF GEAR ARRANGEMENTS

* Abstract of a paper by Mr. J. H. Molloy, managing director of Wm. Muir and Co., Limited, machine tool makers, Manchester, read before the North-Western Section of the Institution of Mechanical Engineers on April 7th last.

wheel solves the whole question, but the practical problem is reproducing as near as possible its accuracy in the cutting of the gears. Lack of adjustment, distortion, excessive wear, hard and soft places in the work or inefficiency in the hob, produce their own extraneous errors, so much so that it is doubtful if the accuracy of the dividing wheel has ever been reproduced in the cutting of the gears.

The question is often asked if one or more cuts are recommended in removing the material from the tooth space. The answer is, one cut where possible, or, if a finisher is desired, the final cut should be in the region of .010in. In the author's opinion, it is at the first stage that the bulk of the small variations are introduced into the work, and once present cannot be entirely removed by a finishing cut. They seem to reproduce themselves. This point does not seem generally known. In removing the material in two half-depth cuts, the first cut is trying to insert a number of teeth in the blank not in accordance with the dividing mechanism. This strain plays upon the want of homogeneity in the blank. Soft and hard places allow the hob in some parts to cut more or less freely, so playing upon the accumulated wear or backlash of the dividing worm. Obviously, the deeper the first cut, the more the hob and dividing mechanism are in accordance and less likely to introduce extraneous errors. A case in point : I have known where a zero section of twenty teeth of the dividing wheel had in the corresponding length of the circumference of the work above it an extraneous added error of .008in.

Similar difficulty arises with the accurate guide screw. My firm has a well-known screw tested by a committee of experts very close to the standard, yet to cut a screw from it anywhere near to accuracy is a very slow and laborious undertaking, only to be undertaken by a highly skilled and experienced turner.

The application of turbine reduction gear is now generally recognised as an established success. Some controversy has arisen quite recently as to whether or not hobbing is the best method of producing this type of gearing, and considering that 90 per cent. of the reduction gears in use have been cut on these machines, is surely satisfactory evidence of the efficiency of the hobbing process.

The machine described has been installed in practically all the principal shipbuilding works in the world. Many of these machines, during the stress of the war period, were running continuously night and day, and the consistent success in the absence of trouble from the dividing standpoint should be realised. The No. 2 size machine, with largest dividing wheel, 8ft. diameter, has had to handle gears 12ft. and 13ft. diameter, and the author believes a gear 14ft. diameter has been produced, a very responsible undertaking, considering the enormous cost of the large blank, and the very slight mishap that can spoil the satisfactory running of the gears. Through the kindness of Messrs. John Brown's, of Clydebank, a case in point may be cited. They required a wheel 12ft. diameter for a very important installation, and as a preliminary precaution made a test cut. A blank was prepared, 12ft. diameter, and parted at the centre. After cutting, the upper half was moved diametrically opposite and readings taken. The pitch error per tooth is negligible. The accumulated error of the worst point in the semi-circumference of 18ft. was ten-thousandths. This, spread among the 200 teeth, shows a pitch error of .00005, and the resulting gears proved an unqualified working success.

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### DISCUSSION.

Professor Stoney, who opened the discussion on this paper, said that the large amount of trouble experienced in many cases, especially in America, was largely due to faulty cutting of the gears. He asked the author which arrangement for balancing the gears was the more accurate, that on knife edges or that on rollers with ball bearings. Professor Stoney also desired to know whether the author found the creep arrangement introduced by Sir Charles Parsons to be a real advantage.

Mr. Sykes said, with regard to the creeping table arrangement, that it was responsible for producing one trouble, an excessively wide tooth space, and he believed that many people who adopted that arrangement when it was first introduced had since discarded it. The first requirement in gear cutting was an accurate dividing wheel, without which neither a creeping table nor any other arrangement would produce perfect results. He thought the balancing arrangement described by Mr. Melloy was a very good feature, and asked whether the whole weight or only part of it was balanced. He had found that it was better to have some downward weight on the table, as there was a tendency for the hob to pull the table forward if the whole weight was balanced. With regard to the hunting tooth, there were many different opinions on that point. He did not think it was very important, provided the wheel and pinion were accurate. It was more necessary between the wheel and the hob when using a multiple thread hob. Although Mr. Melloy rather discounted the idea of using multiple thread hobs, they had certain advantages over single thread hobs. On a wide wheel, in the case of a three-thread hob, the wear was distributed over three sides instead of being all on one side as in a single-thread hob, the actual wear thus being only one-third.

Mr. Reed thought the balancing arrangement suggested by Mr. Melloy was very ingenious, and commended the front cutting angle on the hob. The latter would get over a great deal of difficulty in eliminating the distortion in the blank to be cut. With regard to fixing the machine on the foundation, he thought that better results would be obtained by the adoption of a system of three-point support than by Mr. Melloy's method. Although he agreed that there was a great deal of difficulty in cutting guide screws to within the limit of accuracy given by Mr. Melloy—that is, one-hundredth of an inch in 6ft.—he believed it was possible to obtain a greater accuracy than that.

Mr. Wright referred to Mr. Melloy's point about the undesirable features of sinking in several cuts to get full depth. That, he said, would lead to a rather difficult position in cutting heavy gears, where the work had to be done in successive cuts. He thought such work could best be done by using a roughing hob cutting to full depth, then following with a finishing hob cutting on the sides, and not touching the bottom. With regard to the relief on hobs, he thought it was hardly ever sufficient, the idea seeming to be that the less relief there was on the hob the longer it would last. With a more liberal relief, much freer cutting would result.

Mr. Newton said he agreed with the author as to the necessity for the highest attainable accuracy. He thought that there was much more to be done before manufacturers reached the utmost possibility of gearing. When the firm with which he was connected first took up gearing, it had been faced with the problem of how to measure errors, and had designed and patented a machine for that purpose. That machine had not up to then been made large enough to deal with large wheels, and was only used on pinions up to 10in. diameter. His firm had also adopted a machine for measuring errors in hobs, by which it had been able to effect considerable improvements. He had found it very difficult to get accumulated errors of less than three or four thousandths, but in measuring foreign gears, both American and continental of the best makes, he found they gave a very high degree of accuracy. He agreed that the Americans had in past years had a great deal of trouble, but they had tackled the question in all its bearings, and by getting fairly satisfactory dividing wheels and screws, and attending to the forces involved in cutting, they had obtained surprisingly accurate results. There was one point where he joined issue with Mr. Melloy. The author had pointed out that it was impossible to reproduce the accuracy of the dividing wheel on a wheel being cut ; the errors were always greater. He agreed that that had never been done, but Mr. Melloy drew the conclusion that that being so, the dividing wheel had reached a satisfactory degree of accuracy, whereas he—Mr. Newton—thought the fact pointed to the necessity of still further improving the accuracy of the dividing wheel.

Mr. Cundall asked the author what degree of accuracy he would expect when cutting a wheel 6ft. diameter with 20in. pitch, and, if when taking two cuts, Mr. Melloy would recommend the use of a multiple-thread hob. He thought that a single-thread hob was the best to use on that class of machine, as directly a multiple-thread hob was introduced, it threw the cutting action sideways, putting all the forces and the work on to the master wheel. With regard to the feeds when using two cuts, in the case of a machine with 1/23 feed, he suggested that the first cut should be taken with 1/23 feed and the second with 1/13 feed, as he had found that if the hob was forced on a job running for ninety hours, excessive wear would be induced in the hob, and the front teeth would become so dull as to refuse to cut, and would therefore behave like a worm. That would throw excessive stresses on the hob, driving gear, and frame of the machine.

Mr. Melloy, in reply, said that so many important points had been raised that he would only be able to reply to several of general interest. The amount of relief in the hob tooth was notoriously small, but was difficult to increase. The clearance was obtained by backing off, and could only be increased by a greater throw of the cam in the backing-off process. Even that would only result in a very small increase, and to obtain more would lead to a mutilation of the hob tooth, and probably introduce chatter when working. Massive foundations were necessary and provided for the machine. The bar on which the bed was balanced at its centre of gravity rested on the main foundation, so did the wedges that were inserted to bring the top surface of the bed into the horizontal plane. The whole was then grouted in. Mr. Reed's suggestion of a three-point support, in Mr. Melloy's opinion, did not meet the requirements, and might lead to difficulties, because if the bed sank in the middle, owing to the great weight of the gears, the three-point support went with it. With regard to Mr. Sykes' reference to the increase in the space of the teeth cut on the creep, he said that was a fact, and was to be expected, for if any error was "crept," it must appear as an increase in the space. It was well known that any departure from normal, whether through drunken teeth in the hob or incorrect setting of the angle of the spindle slide, would produce a space greater than the hob tooth. It should be pointed out that the hob for creep cutting had a thinner tooth to compensate for this alteration. Mr. Melloy thought it due to the creep that the "singing" in the gears was overcome. Originally the gears were cut equal tooth and space. The creep automatically increased this space, permitting a cushion of lubricant, which made a marked improvement in the quietness of the running. After that experience when using the solid table, the hob was made to produce a greater space than the tooth. Professor Stoney asked if it was not a fact that some firms were giving up using the creep. That was so. However well the creep might work when first installed, the excentrically placed gears which caused the table to advance round the main dividing wheel and so distributed the error round the work being cut, were subject to wear and could certainly introduce unknown extraneous errors into the work that would be greater than that contained in the master wheel. From the engineer's point of view, the fewer gears and bearings involved, the greater the probability of accuracy. Mr. Melloy quite sympathised with Mr. Newton's remarks, pointing out that he had himself spent thousands of hours chasing thousandths. At the same time, if Mr. Newton could not always get the extreme accuracy he demanded, he could, at any rate, have given to him practically perfect working results. Mr. Newton had pointed out the wonderful results obtained by American gear cutting, which seemed to give the impression they were in advance of the English in that type of gear cutting. In that he could not agree. With regard to the effect of wear in the hob when cutting, it was a matter of experience that the wear of the hob in the finishing cut per tooth was negligible. The amount of wear depended greatly on the length of time the teeth were rubbing. A hob would wear practically as much if it took the same time to travel 1in. as it did to pass through the work. Consequently, strange as it might appear, a hob with efficient routing capacity would wear less by traversing quickly through the work at as big a traverse as good finish would permit.

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BOVEY LIGNITE.—Referring to a paragraph in our "Sevenday Journal" of April 28th, Mr. Martin C. Olsson assures us that not a single German was interested in the undertaking and no German money was subscribed.

## The Manufacture of Optical Glass.

THE following outline description of the process of making optical glass is taken from a paper read before the Optical Society by Dr. C. J. Peddle.

In the manufacture of optical glass there are many points to be taken into account, and some of these may be set out as follows :—

(1) Each glass must have certain refractive indices for various wave lengths of light, and successive melts of the same type of glass must only vary within narrow limits in their respective indices.

(2) The glass must be as free from bubble as possible.

(3) No veins must be present. Absence of veins or striæ, visible to the naked eye alone, is not sufficient, and glass has to be examined on a special instrument for the presence of "fine striæ."

(4) Even in pieces 1in. or 2in. thick there must be practically no colour. In addition, freedom from colour must be brought about without use of "decolorisers," such as manganese dioxide, nickel oxide, or selenium, because the glass must transmit a maximum of light.

(5) It is essential that the glass shall be very durable, that is, it must preserve its polished surface undimmed and without disintegration after long usage under all climatic conditions.

(6) The glass must be free from strain, and so demands a high degree of annealing, a particularly delicate operation with thick pieces of glass.

(7) The working properties of the glass must be such that it can be easily fashioned into lenses and prisms. It must not be too hard nor too brittle, so that it may be ground and polished.

(8) The batch mixture must be such as to admit of easy founding under normal glass melting conditions, and must yield a glass of sufficiently low viscosity, when molten, to admit of easy stirring.

(9) After stirring, the pot of optical glass is allowed to cool down *in situ*, and is broken up when cold. This cooling must be at a fairly slow rate (a matter of days), so that fairly large pieces of glass are available. Slow cooling introduces another pitfall into the operation, namely, the separation from the glass of one or more of its constituents, leading to "devitrification." Thus, care has to be exercised that composition and rate of cooling are such that no separation takes place.

It will be seen that many difficulties stand in the way of the production of first-rate optical glass, and the reason will be appreciated why often less than 10 per cent. of the glass melted is saleable. Perhaps the greatest difficulty, and one not mentioned above, is the pot in which the glass is melted. In the writer's opinion only this pot difficulty stands between the optician and glass of a quality hitherto unattainable either in quality or price. Molten glass has a very corrosive action upon the clay of which glass melting pots are made. This results in the absorption by the glass of iron, alumina, and silica. Iron absorption is the cause of the colour in optical glass, and the incorporation of alumina and silica largely accounts for the striæ and at the same time increases the difficulty in obtaining the desired optical constants of the glass melted. If only a suitable refractory could be obtained upon which glass, when molten, had little or no action, many of the difficulties of glass melting would disappear. It must be said, in passing, that the search for such a refractory is incessant at Derby. Considerable time and much money have been spent upon it, and improvements have been introduced.

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## RAILWAY METALS DAMAGED BY WELDING.

A DECIDED weakening of steel T rails has been found to be caused by attaching electric bonds to them by welding in connection with the development of a theft-proof rail bond for the Mexico City street-railway system. Some tests, described in the *Engineering News Record*, were made by the Pittsburg Testing Laboratory for the Canadian Engineering Agency, Inc., of New York, and indicate that drop-test results on rails with welded-on bonds are less than one-half as good as the results obtained with corresponding pieces of rail having no bonds attached.

Loss of exposed copper bonds by theft became serious enough on some lines of the Mexico system to make a concealed bond desirable, and a bond was devised comprising two strands of No. 0 copper cable connected at the ends by spear-shaped cast copper terminals faced along the outer edge with ¼in. of steel. The bond was designed to fit under the standard fish-plate, passing around the bolts, and was to be attached to the rail web by means of electric arc welding of the steel facing to the rail metal. To determine whether this method of attaching a bond affected the strength of the rail, comparative drop tests were made on 4½ft. lengths of the rail (70 lb. T-rail, 6in. deep), under the standard drop-test machine of the American Railway Engineering Association specification (2000 lb. ram with 15ft. drop). Bonds were attached to about half the number of test pieces, in some cases with one of the terminals at mid-length of the specimen, in other cases with the two terminals symmetrically placed with respect to the mid-length of the rail. No more welding material was used than would be considered good practice, the test report states, and the welding process did not heat the rail to a noticeable degree.

In the tests, the unbonded rail specimens broke on the third to fifth blow, while the bonded specimens broke on the first blow. In a second series of tests the height of drop was reduced to 10ft. ; the unbonded specimens broke on the fourth to fifth blow, while the bonded rails broke on the first or second blow.

It was concluded from these tests that "serious injury is done to a rail by the welding process applied to its web," and the welded bonds therefore were not adopted for use. A form of bond passing under the joint and attached to head or base of the rail by welding may be adopted, however, as welding to the more massive parts of the section is not believed to injure the rail.

## Railway Matters.

THE annual salaries and wages bill of the Great North of Scotland Railway rose from £157,000 in 1913 to over £600,000 in 1921.

THE Chicago, Rock Island and Pacific Railroad is proposing to equip radio-phone and radiograph outfits on its Rocky Mountain Limited and Golden State Limited expresses, so as to provide passengers with news bulletins during the day and musical concerts in the evening.

AS indicative of the stagnation in trade, it may be mentioned that the four railway companies which represent the London Electric Railways carried last year 339 million passengers or 65 millions less than in 1920, and of the latter, 21 millions were workmen, a decrease of 28 per cent.

THIRTY stations on the Midland Railway are "closed," *i.e.*, no one may enter without a ticket. People who are not passengers and wish to go on to the platform have to purchase "platform tickets." These tickets cost one penny each, and last year 1,610,000 were issued, which means an income of £6708.

UNDER the Railways Act, 1921, the directors and auditors of railway companies absorbed and amalgamated under the grouping scheme may receive such compensation as the proprietors approve. The Taff Vale directors are to receive the sum of £22,500 to be divided amongst them, whilst 550 guineas are to be divided between the auditors.

AS the London and South-Western capital account has now been credited with £85,000 for the Basingstoke and Alton Light Railway, it is evident that the track, which was taken up and sent overseas, will not be replaced. The light railway was opened in June, 1901, and in no single year did the revenue approach the cost of working.

NOTICE is given by the Rates Advisory Committee, 2, Clement's-inn, Strand, London, W.C. 2, that the railway companies have submitted proposals for the classification of traffic, other than perishables, when conveyed by passenger train or other similar service. Copies of the proposals may be obtained from the Secretary, Railway Clearing House, Seymour-street, Euston-square, London, N.W. 1, for a few pence.

THE expenses of the Ealing and Shepherds Bush Railway exceed the receipts. The number of passengers during 1921 was estimated at 3 millions in contrast to about 9 millions carried by the Metropolitan District Railway to the same area. This is considered by the Central London Railway Company to be due to the high fares, which, since the railway is part of the Great Western system, are on the pre-war rate, plus 75 per cent.

OWING to war conditions, the re-painting of the Great Western coaching stock fell into arrears—this statement is made by the company's officials—and it has now been decided to revert to the original Great Western colours—chocolate brown for the lower part of the carriage bodies and cream for the upper panels. Bogie stock will be dealt with first, and it is hoped that when the summer service begins, vehicles of these colours will be on the Cornish Riviera expresses.

WHAT looks like a repetition of the unfortunate accident of January 4th near East Horndon, on the Tilbury section of the Midland Railway, occurred on Friday morning last on the Crewe-Manchester section of the London and North-Western Railway. One of the connecting-rods of an engine would appear to have broken and the loose end to have pierced the fire-box, causing fire and steam to be forced out of the fire-box door. The fireman was thrown on to the permanent way and killed, and the driver was seriously injured.

WHAT might have been a serious accident occurred on Friday, the 21st ultimo, at Johnson's Sidings signal-box, Ambergate, on the Midland Railway. As the 12.25 p.m. express from St. Pancras to Manchester was passing that place some carriages were derailed at the crossing of the siding connection. The box is situated about a mile north of Ambergate, where, owing to severe curves, there is a speed restriction of 10 miles per hour, so the train was travelling slowly and the personal and material damage was very slight.

RAILWAY servants for nearly forty years have had the privilege of obtaining for themselves and their dependants tickets at one-quarter the ordinary fare. During the last few years, when their pay has been so much higher than formerly, the question has been often raised as to why this privilege should be continued. The answer is that it is a condition of service that cannot be withdrawn without the companies being guilty of a breach of faith. From information given recently it appears that during the year 1921 the Midland company issued 1,676,626 privilege tickets.

ONE of the most serious accidents of late on the railways of the United States occurred on December 7th last at Bryn Athyn, near Philadelphia, on a subsidiary line of the Philadelphia and Reading Company. An east-bound passenger train, No. 151, received orders to cross No. 156 west-bound passenger train at Bryn Athyn, the line being single. To allow No. 151 to draw forward and back into the siding, No. 154 west-bound train was kept outside the station, and when No. 151 was in the siding No. 154 proceeded on its journey. The station agent was then asked by the next block station to allow No. 156 to approach, and No. 154 having gone forward and No. 151 being in the siding, this permission was granted. On turning round, the agent saw No. 151 on its way east, and soon after it met No. 156. In the collision and resultant fire in the coaches, twenty passengers and seven servants were killed. The investigation by the Bureau of Safety of the Inter-State Commerce Commission, says the report of that body, "disclosed a general laxity in the observance of block signal rules. . . . There was no uniform understanding as to whether the siding at Bryn Athyn was in the limits of the station or in the block section between Bryn Athyn and Churchville. . . . Employees are not regularly examined on the rules, and some of them have not been examined since 1914. The train dispatcher had never been examined. Trains appear to be authorised frequently to disregard automatic block signal indications on trivial occasions to avoid delay."

## Notes and Memoranda.

THE cotton mills of China possess a total of 2,066,582 spindles, of which 1,180,406 are of British make, 722,096 are American and 164,080 are from other countries. The ownership of the spindles is divided approximately in the proportion of 2½ British to 3½ Japanese and 5 Chinese.

THE following remarkable rainfall is mentioned in the *Engineering News-Record*. Between the hours of 9 a.m. and 5.30 p.m. on March 25th, a rainfall of 7.15in. was recorded in Houston, Texas. The streets resembled rivers. Between 12 noon and 12.05, 0.40in. of rainfall was recorded. Block pavements were torn up and floated away from the streets on which they were laid.

ALTHOUGH no very serious damage was done to the electrical power plant on the Rand during the recent revolutionary outbreak in South Africa, some of the transmission line towers were wrecked. An illustration in the *S.A. Mining and Engineering Journal* shows one of these standards completely destroyed at the base, but supported from the adjacent towers by the transmission wires themselves, and still in service.

THE latest statistics compiled by the Canadian Department of the Interior show that, while the water power of the country could be depended upon for six months in the year to give 32,076,000 horse-power, up to the present only 2,763,000 horse-power has been developed. The total installation for the Dominion averages 315 horse-power per thousand population, a figure which places Canada second only to Norway in the per capita utilisation of water power among the countries of the world.

SOME particulars are given in the *Engineering News Record* of the overhauling of two bascule bridges on the Cleveland, Cincinnati and St. Louis Railway. The bridges had been in service about twenty years and had both been operated more than 50,000 times. The rolling treads and flanges of the tracks were badly damaged by excessive loading, which is estimated to have amounted to 14,350 lb. per square inch, assuming a longitudinal distribution of 6½in. The tracks have been repaired and altered so as to reduce the loading to 9000 lb. per sq. in.

A SCHEME which, according to *Indian Engineering*, should produce remarkable results, is about to be undertaken in the island of Hawaii, the proposition being to make extensive drillings into the great active volcano of Kilauea in an endeavour to determine the heat of the volcano, the quantity of steam underneath, the mineral constituents, and the solution of other relative questions. Borings are to be undertaken at the sulphur banks, at several places in the bottom of the crater, and in the region of recent lava flows at Kau Desert. It is intended to penetrate the surface where the lava flows are of known date, so as to learn what changes of temperature underground have taken place with the passage of time.

COPPER slag purchased at 9s. 1d. a ton delivered, as against 12s. asked for blue metal, will in future be used by the Hurstville Municipal Council (Sydney) for road-making purposes. Hitherto, no commercial market whatever could be found for the slag, a huge mound of which has accumulated in the yards of the Electrolytic Refining and Smelting Company's works at Port Kembla. Exhaustive tests, it is stated, have been carried out, and the Council has entered into a contract to take 18,000 tons of the slag from the Refining Company, and has arranged to erect a crushing plant and bins costing £4000. It is expected that the entire cost of the plant will be written off in the course of the first year's operations by the saving of the difference between the cost of slag and blue metal. It is claimed that the slag is more economical and will wear better than the metal.

SOME measurements of the expansion of nickel, monel, metal, stellite, stainless steel, and aluminium, made at the American Bureau of Standards, were carried out from 0 deg. to 600 deg. and 900 deg. Cent. Stainless steel was the only one of these metals whose expansion curve departed much from a straight line; this material has a sharply defined irregularity of large range between about 800 deg. and 855 deg. Cent. Nickel was found to have a coefficient of expansion in a range of moderate temperatures (below that of boiling water) of about 13 one-millionths per degree, which is 10 to 20 per cent. greater than that of steel. In the range from 300 deg. to 600 deg. Cent. the coefficient rises to about 16½ one-millionths. Monel metal had closely similar values, about 14 for the range from 25 deg. to 100 deg., and 17½ one-millionths for the range from 300 deg. to 600 deg. Various samples of stellite (an alloy of cobalt, chromium and tungsten, sometimes with iron) ranged from 11 to 15½ units for the lower range to 14.7 to 18 units for the higher range. Stainless steels showed a coefficient of about 10 units in the lower range and 13½ in the upper range. Aluminium showed an expansion coefficient of about 23½ below 100 deg. and about 36 one-millionths in the neighbourhood of 600 deg. Cent.

IN the annual report of H.M. Inspectors of Explosives the following account is given of the explosion of a tank wagon while it was being filled with benzole:—"There is good reason to believe that the engine was running at the time, and the wind was blowing strongly from the tank wagon that was being filled at the next stand-pipe. This would cause a considerable quantity of vapour to be ejected from the manhole and to be driven over the engine of the tank which exploded. Either a spark from the magneto or perhaps merely a piece of white-hot carbon deposit thrown out of the exhaust pipe would be sufficient to ignite the vapour, and as the so-called empty tank would probably contain a highly explosive atmosphere, this would be enough to account for the accident. This accident tends to confirm the view that we have frequently expressed—that these tank wagons should be filled by means of a pipe leading right to the bottom of the tank, and that the filling hose should be attached to the top of this pipe by a screwed union. The necessary vent should be covered by a diaphragm of fine wire gauze, and the dipping hole should also take the form of a pipe reaching to the bottom of the tank. The gauze of the vent must, of course, be protected by a hinged lid or otherwise, which would have to be opened during filling and emptying."

## Miscellanea.

THE Kiangnan Dockyard proposes to build a new dock-yard along the Bund, Shanghai.

ACCORDING to the Russian Trade Delegation, a large "Electrification Bank" is being organised with the participation of foreign banks, notably the Credito Italiano, to promote electrification works in Russia.

ORDERS have been given for the commencement of blasting operations in the upper reaches of the Yangtze River, China, with a view to facilitating the passage of steamers and so assisting commerce with the province of Szechwan.

ACCORDING to the United States Consul at Helsingfors, the Arabia Porslinsfabrik A/B, of that city, has installed a testing department with a capacity of 300,000 volts for testing high-tension material. It was built by the Allmanna Elektriska A/B in Finland, and is said to be the only one in northern Europe where tests can be effected with such a high voltage. The Arabia Company has made insulators for the past twenty years, but not hitherto for such high tensions as are now required.

THE principal conclusion arrived at by the Miners' Nystagmus Committee of the Medical Research Council is as follows:—The essential factor in the production of miners' nystagmus is deficient illumination. Other factors, such as position during work, accidents, alcoholism, infections, malnutrition, hereditary predisposition and errors of refraction, are of secondary importance only, while depth of workings, thickness of seams, and the ordinary gaseous impurities in mine air have no direct influence on the disease.

A STUDY of the possibility of predicting earthquakes by geodetic measurements is being carried on by the Carnegie Institution, at Washington. According to the report of the Director of the U.S. Coast and Geodetic Survey, just issued, "seismologists agree that earthquakes are due to abrupt adjustments of accumulated strains in the earth's crust. It is believed that the stresses as they accumulate, prior to the actual convulsion, may cause a gradual distortion of the surface of the earth which can be detected by geodetic methods."

THE number of vessels of all kinds launched from the Tyne during the month of March, 1922, was five, of an estimated net register tonnage of 19,345 tons, as compared with five vessels of an estimated register tonnage of 17,350 launched during the corresponding period of 1921, while for the first three months of the current year there were eleven vessels launched, of an estimated net register tonnage of 43,235 tons, as compared with twenty-four vessels of an estimated net register tonnage of 60,749 tons launched during the corresponding period of last year.

THE output of iron and steel in Japan has fallen off considerably since 1919, and a further reduction is looked for when armament limitation becomes effective. The production of the Yawata Steel Works for 1919 amounted to 610,000 tons of pig iron and 550,000 tons of steel. In 1921 the output was 500,000 tons of pig iron and 530,000 tons of steel. It is said that foreign iron and steel are imported and sold at lower prices than the Japanese manufacturers can meet, and that the armament limitations will reduce the output of finished steel by about 60,000 tons annually.

ALTHOUGH extensive boring operations have been carried on in Switzerland in the Jura Mountains, coal has so far not been struck. French and German mining experts assert, however, that coal seams exist in the Buix district. The boring operations have been subsidised by the Federal Government to the extent of 450,000f., provided that a further 1,050,000f. were subscribed by the public. This amount has been found. In the autumn of 1921 boring operations were suspended until labour became cheaper. The opinion is expressed that coal mining in Switzerland has small prospect of success, and, in view of the resumption of more normal conditions in the import trade, it is difficult to see what other view could be taken.

AFTER discussions extending over two years, the Strasburg Municipal Council has approved the plan submitted for the extension of that port. The plan provides for the creation of a new body, the autonomous port of Strasburg, in which it is suggested that the State and the town should be closely associated, and which would take over the care and management of the services existing or to be created. The present basins with their eventual extensions would be controlled by an administrative council with a director. This council would consist of fifteen members, six appointed by the State, six by the town, one by the Conseil Général du Bas-Rhin, one by the Chamber of Commerce, and one by the Port Workers' Syndicate. The value of the town's contribution is estimated at 100 million francs. The free port would be authorised to raise a loan of the same amount, the interest on which would be guaranteed by the State. The project having been unanimously approved by the Municipal Council is now to be transmitted to the Government, which will lay it before the Chambers shortly.

IT is reported from Chicago that the Rockport Steamship Company, of Sheboygan, Wis., has awarded a contract to the Manitowoc Shipbuilding Corporation, Manitowoc, Wis., for the construction of a self-discharging steamship, with capacity for 7500 tons of cargo to be used mainly in the handling of coal, broken stone and gravel at Great Lake ports, where the more modern discharge facilities are not available. The cost of the vessel will be approximately 700,000 dollars. The ship, it was stated, is to be 450ft. long, with a 56ft. beam and a 30ft. depth of hold. The method of construction involves an endless belt running the length of the ship and arranged just over the keel, on to which the cargo from the various compartments will be dropped. This belt will, in turn, discharge the cargo on to another belt furnished with carrying buckets, by which it will be elevated to the upper deck and again discharged on to a swinging travelling belt, thus carrying the contents clear of the ship to containers alongside the dock or into storage. It is estimated that a full cargo will be discharged in from four to five hours.

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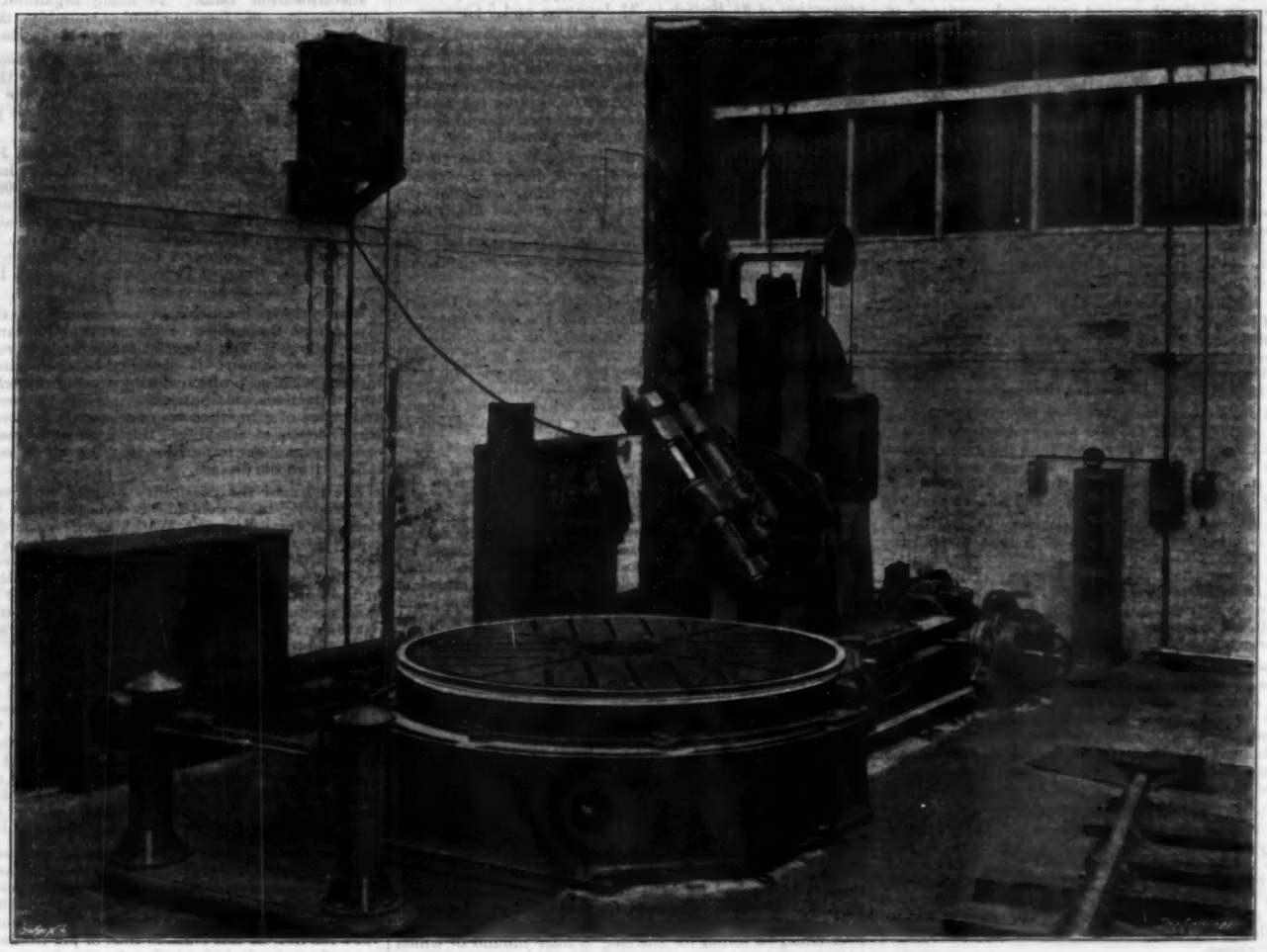

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**The Engineer.**

526, Bolsa de Comercio, Buenos Aires.

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THE ENGINEER can be had, by order, from any newsagent in town or country, at the various railway stations; or it can, if preferred, be supplied direct from this office.
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TWO PAGE SUPPLEMENT—THE CARELS FACTORY AT GHENT.


# THE ENGINEER.

*MAY 5, 1922.*


### Stresses, Calculable and Incalculable.

ALTHOUGH the scientific engineer rightly relies to a very large extent upon the calculated values of stresses in the working parts of his machines and structures, practical experience, as well as a closer theoretical consideration of the question alike go to show that at times materials are exposed to very much more intense loading than that which had been anticipated from ordinary data and calculations. The mere fact that failures sometimes occur in parts where no defective material can be traced and where the calculated working stress was far below even the specified yield point of the material, serves to establish the occurrence of such cases. Fortunately, however, actual failures from such causes are very rare and represent only a small fraction of those cases in which the actual working stresses are very considerably greater than those indicated by calculation. Now we do not desire, by raising this point, to throw any doubt upon the fundamental value of stress calculation. On the contrary, we would insist rather upon the importance of so improving our methods of calculation that such cases may be increasingly eliminated. At present the uncertainty which exists under this head is one of the factors which remains to be covered by the "factor of safety," but it is fully recognised that engineering progress, particularly where requirements regarding weight are stringent, often implies an enforced cutting down of these wide margins and, therefore, a fuller utilisation of the strength of the materials employed. Elimination of uncertainty as to the actual stresses involved must therefore also be eliminated to an increasing extent.

At first sight this would seem to be little more than a plea for a fuller development of the mathematical side of the theory of structures and materials, but while such a development is required, we would draw particular attention to another aspect of the matter. It relates to the closer study of the materials upon which the stresses have to act and of their behaviour. The mathematical basis of calculations always requires the material to be uniform and isotropic—*i.e.*, that it should have not only the same strength, but also the same elastic properties in all directions. Actually, in the case of timber, it has been found that this property is lacking, while there is room for doubt even in the case of metals. As regards strength, at all events, longitudinal and transverse properties differ very widely in rolled and drawn materials. The whole problem is, however, affected to a very much greater degree by an entirely different factor. This factor is the existence in many materials of important internal stresses, *i.e.*, of stresses which exist in the material in the entire absence of external load. Such internal stresses arise when a piece of metal has undergone changes of shape or volume which are not uniform throughout its mass. For instance, when a rod or tube is subjected to cold drawing, the outer skin is extended to a slightly greater degree than the inner portions. At the end of the operation the material is left in a stressed condition, with the "extended" skin under elastic compression and the remainder in tension, both stresses being such that they suffice to equalise the dimensions of the two portions of material. The presence of such internal stresses is readily ascertainable by cutting up the metal in a suitable manner. If, for instance, in the case referred to, the outer compressed skin is cut through so as to leave it free to contract, the total dimensions of the tube are diminished by a slight amount. Stresses can be detected in this manner, which, on calculation, indicate that the material was internally or "self-stressed" to a point not very far below its normal breaking stress. The point which we wish to emphasise, however, is that if external loading is applied to material in such a condition, where the internal stress has the same sign as the applied stress, the two add up and fracture, or dangerous nearness to fracture, may result at a point where the calculated working stress is quite moderate. Now the presence of such internal stresses in cold-drawn or otherwise cold-worked metal is well recognised and constitutes one of the reasons why, for many important purposes, cold-worked material is regarded with justified suspicion by designers and users. The very great convenience of such material, however, presents a temptation towards its use which is not always resisted. Fortunately, it has recently been established, principally by Dr. Moore and his collaborators at Woolwich, that by heating cold-worked brass, for example, to quite a low temperature such as 300 deg. Cent. for a short time, the internal stresses can be very largely removed without appreciably weakening or otherwise altering the properties of the material, and doubtless similar treatment is possible with other alloys and with steel. If it were universally applied, much of the present mistrust of cold-worked metal might be overcome. There are, however, other sources of internal stress in metals besides the cold-working operations usually so-called. These cases are in reality more dangerous than the others, since the presence of serious internal stress is not always recognised. One group of such cases arises from heat treatment involving rapid cooling or quenching. The hardening of steel, even if of a relatively mild nature, involves changes of volume, and these changes do not occur at the same time and to the same extent throughout the mass. The resulting differences of dimensions thus have to be equalised by elastic strains, and in some cases actual rupture results in the formation of the familiar hardening cracks. In other cases the material remains intact, but severely stressed internally. Subsequent tempering, provided that it is sufficiently drastic, no doubt serves largely to wipe out these heavy internal stresses, but important residual stresses frequently remain. In certain alloy steels, for instance, the tempering itself must be followed, if "temper brittleness" is to be avoided, by a second quenching or rapid cooling, and although this is not so severe as true hardening quenching, it may yet cause cracking or set up important internal stress. Another form of "heat treatment" which may, and sometimes does, cause serious internal stresses is the process of autogenous welding, whether by the electric arc or the acetylene flame. Local heating inevitably causes differential expansions and subsequent contractions, and the possibly heavy resultant stresses should be fully considered in connection with the loading of parts which have been treated in this way.

Heat treatment is not, however, the only source of internal stresses, mechanical deformation applied in the cold during manufacture or construction being a still more serious cause. Whenever a piece of metal is bent cold, although apparently entirely uninjured and possibly even hardened by the operation, it is inevitably left with a certain measure of internal stress. In the simple bending of a strip or plate the portions near the neutral axis are stressed only within their range of elastic recovery, while the outer portions undergo permanent plastic extension or compression. When the external bending force is removed the inner elastically strained portions tend to re-straighten the piece, but are resisted by the permanently deformed outer portions; a system of counterbalancing internal stresses is thus set up. A still more striking case arises from such operations as riveting. Quite apart from such manipulations as forcing holes to meet when the fit is not quite perfect, and similar

forcible proceedings, the closing of the rivets and their subsequent contraction during cooling, imposes very high and localised stresses upon the rivets and plates. These forces come upon the material precisely at those points where working stresses are highest and, in unfavourable circumstances, failure may result, perhaps only after the lapse of many years. These considerations need not and, of course, will not alarm us in any way. In the vast majority of cases our structures are amply strong enough to resist these internal stresses when added to the low working stresses, but they should be taken into account where they exist and their existence should be avoided wherever possible.

### Breakdowns of Machinery.

A considerable degree of circumspection is always advisable before an adverse opinion be passed on any machine which is in the process of development solely on account of mechanical troubles in the early stages, and it sometimes requires more than even the occurrence of a series of serious accidents to justify condemnation of any engineering structure which is the outcome of long years of satisfactory experience in design and operation. Any part of a machine may break, not once, but repeatedly, without the verdict on the principle or even on the detail construction of the whole being necessarily unfavourable. Nor is it ever wise to jump too rapidly to conclusions that, because certain accidents have occurred, all bearing the same strong family resemblance as to cause and effect, the remedy may not, after all, be a fairly simple one and applicable, moreover, without any special alteration in design.

Reflection may perhaps bring to light the existence of entirely new phenomena, the unforeseen action of which is responsible for wholly unexpected consequences. The breakage of screw propeller shafting owing to torsional vibrations assuming unanticipated magnitude is a case in point. So also was the extraordinary rapid erosion of propeller blades in certain of the early turbine vessels. Both were easily remedied. The occasional bursting of grindstones has neither led to their suppression nor even given rise to an alternative method of sharpening tools. Nearly 40 per cent. of the accidents to ordinary steam engines occur in the valve gear, but that fact is not taken to mean that valve gear is intrinsically weak so much as that it is generally the weakest link in that particular mechanical chain. The repeated failure of boiler tubes did not condemn the principle, nor, broadly speaking, even the detail design of water-tube boilers, and no consideration of accidents to machinery is of the slightest value unless it takes the fullest account, not only of what has broken, but also to what extent similar designs have been operated without difficulty. What, for instance, is the numerical ratio between broken crank shafts and those that run satisfactorily, or between the failures of marine reducing gear and those that never give trouble? It must never be forgotten that the fault may not lie entirely in the part that breaks. Failure may obviously occur under circumstances which should never have arisen at all—a palpably weak connecting-rod jaw, for instance, or failure to calculate properly the real stress, or bad workmanship in the important members of a big bridge—but these are isolated instances which create a demand for immediate remedy. Again, the fault may lie in what is the commonest and consequently often the least striking cause of all. The factor of safety may have been reduced just a little too far; not far enough, be it remarked, for the weakness to become apparent immediately, but just so far that any extraneous influence may eventually suffice to turn the scale against it. In this direction lie the most aggravating and expensive sources of breakdown that are apt to occur. As a rule they do not reveal themselves until the machines affected have been in operation for a considerable period, by which time there may be a large number of similar designs at work, all of which in consequence at once become to some extent the object of suspicion. Such a case was that of the repeated failure of the "wrapper" plates of the lower drums of water-tube boilers fitted in the light cruisers built just before the war; after a few unfortunately serious accidents vessel after vessel had to lie up, when sorely needed, for a highly inconvenient alteration lest a worse thing befell them.

It is, therefore, with a full appreciation of the wide diversity of the nature of accidents to machinery and the remedies which they call for rather than with any desire to criticise that we draw attention in a couple of articles, of which the first appears to-day, to certain sources of failures in large steam turbine generating plants which have occurred in the last three or four years. These troubles are international; they are not confined to one make of turbine or to one firm, but have been met with in America, Britain and Germany. It is impossible to overlook the fact that such accidents as these involving the complete wrecking of the whole machine, are very different from mere temporary breakdowns. In these circumstances it is proper to inquire, in the first place, if such failures are inherent in the design or manner of use of the machines or are the result of accident or mismanagement. If they are to be attributed to the unsuitability of the design or the material employed for the service they are required to fulfil, then in the second place we must ask ourselves if it is better to modify the design or the conditions, or, being satisfied that it is desirable to retain both of those things, we must inquire if the factor of safety can be increased by the adoption of a new material. The failures appear to be due primarily to the employment of very high speeds in impulse turbines. That these speeds are accompanied by cheapness owing to reduction of size and weight is admitted. On that account they are worth while if they can be obtained without the sacrifice of reliability, and makers may be encouraged to seek for such improvements of design and increase in the strength of material as may remove the element of anxiety which has been caused by the failures recorded.

## Some Post-War Problems of Transport.*

By Sir John Audley Frederick Aspinall,
Past-President, Inst. C.E.

Transport problems have undoubtedly become of much greater interest to the majority of our citizens since the war, partly because such a large proportion of our manhood had opportunities of seeing how much these questions affected the progress of our armies, and, again, because of the paramount necessity of economy in everything which affects the productive power of the nation. There is no section of our citizens which has not an interest in the economical transportation of the passenger, and all are affected in some degree by the cost of the carriage of goods as bearing on the price of the commodities they consume, though the merchants and manufacturers, who have to pay away large sums for carriage, have this question of cost brought home to them in a more wholesale way. In addition to the question of cost, there has been a demand on behalf of the town dweller that he shall be given additional facilities to get away easily and cheaply into a better atmosphere, and the genuine desire to find healthy dwellings for the working classes has made it imperative that our facilities for travel shall grow on a generous basis, consistent with an adequate return to those who provide them.

### London Passenger Traffic.

The ever-increasing growth of London makes it necessary to look forward to the time when greater facilities will exist for taking the teeming population to and from work. It was only by degrees that the growing demand of the suburban traveller became so insistent that means of some kind had to be found by the main line railways for dealing with a traffic which the original designers of the line had never anticipated. Under these circumstances it is very creditable that they should have been able to get over the immense difficulties involved. Other lines of way have, however, in modern times been added for this local traffic, and the notable addition of the tubes has, with their very effective management, enabled many thousands per day to be carried with comfort and rapidity. It may be of use to glance at some of those detail points which help travel.

### Construction of Cars and Stations.

The methods of approach to platforms is of great importance, and those most modern stations where we find the escalator starting from the street level and leading down to platform level between the two platforms, are examples of careful design which are a vast improvement on those older stations where people have to pass upstairs and downstairs and through lengthy and tortuous passages before they reach the train. The presence of plain directions well lighted, and placed in positions which ensure their being seen, saves much time. The construction of the carriage stock has an important bearing on quick loading, and it seems to be eminently desirable that when a passenger enters a car he should be able instantly to see when there is an unoccupied seat to which he can go.

It is a mere Utopian vision to hope that the seating room can ever be so ample that strap-hanging will be abolished in rush hours, and it therefore becomes necessary to consider how the strap-hanger can be accommodated in such a way as to make his standing position as comfortable as possible, and yet arrange that he shall not stand in the way of movement of others. The holding on devices appear to be of two orders, the usual strap and the iron pillar. The latter is of more recent use, and appears to be less desirable than the former.

The number of doorways on the side of a car and their width, whether for one file or two files of passengers, are points not only of importance to the traffic superintendent, but also to the carriage builder, who does not want to weaken the structure unduly by cutting away the sides. The necessity of quick loading and unloading of a car means that the doorway arrangement has to be considered, and, as in most cases, the stream of ingoing passengers has to wait until those outgoing have passed out, there is a great deal of delay which might be avoided if stations were constructed differently. This trouble of loading and unloading can very largely be got rid of by spending more money on new stations and putting in three platforms instead of two. It is then possible to load all passengers on the near side of the trains at the side platforms and to unload them all at the offside at a central island platform. Passengers can then begin to enter the train the instant its tops, and do not conflict with those going out, and several seconds per stop can be saved. The stream of outgoing passengers from both up and down lines on the central platform pass out without obstructing those joining the train. The greatest possible attention should be paid to the continuous flow of passengers and all steps taken to prevent any interruptions of the flow by dividing the incoming and outgoing streams.

The question of dealing in a comprehensive way with London traffic is one which has been spoken of by so many people, and so many divergent views have been expressed, that it looks as if we want a dictator to lay down certain definite broad lines on which future development should take place. Very carefully thought out plans have been prepared by the tube companies for extensions both south and north of London, and also for additions to the existing lines within the most populous routes of to-day. In those places where traffic density is greatest, proposals have been considered for running new tubes at a lower level beneath the existing ones, with fewer stations, thus supplying the demand for quicker long-distance travel.

Sir John here exhibited a diagram based on the reports of the London traffic branch of the Board of Trade, which showed how the stream of railway passengers arrives in London by our railways other than the tube lines, different hatching being employed to indicate the flow of ordinary passengers and of those using workmen's tickets. The general effect of the diagram was to show how large is the traffic in certain directions, notably towards the east, and how it appears likely that in the future provision will have to be made for London's growing population to live, and therefore to travel, in those directions—north-west and south-west—which have as yet much more blank travel space on the map. Similar diagrams were also given concerning road traffic. They exhibited much the same condition of affairs as did the railway diagram.

It will be observed, said Sir John, how the traffic begins at each extremity of the star, as a tiny trickle, growing greater with swelling volume as it approaches London, but not so difficult to deal with as it does not all come at once, as different employments call for different hours of starting work. In the evening, however, the flood of return demands different treatment, coming as it does with a rush, when the terminals and the train capacity are taxed to the utmost.

It is true that the greatest possible frequency of trains becomes absolutely necessary, and so crowded out are the eastern stations of London, that the saving of seconds becomes of importance, and the spending of minutes seems an extravagance. Admirable as may be the organisation which cuts down the time spent in steam operation of suburban trains, it would appear as if London traffic can henceforward only rely on electrification to supply the ever-increasing demand for great frequency of trains, coupled with adequate seating capacity in the most modern rolling stock.

Meanwhile, the railway traffic is helped by the ubiquitous motor omnibus. How great a part the motor omnibus has taken in carrying the London public is indicated by the fact that, in 1921, the London General Omnibus Company handled 761,250,000 passengers, which is just about one-half of the figure shown for all the railways of Great Britain, which, in the most recent returns, for 1919, sold 1,577,194,497 tickets to ordinary passengers and workmen. While the passenger train mileage on all those railways was 227,397,353, the omnibuses ran 87,000,000 miles, so that, by running about one-third of the railway mileage, the omnibuses picked up about half as many ticket-purchasing passengers as all the railways carried in this country, with their much more expensive organisation and equipment. The improvement of the motor omnibus has been so great, and its capacity for handling very large volumes of traffic has so recently been demonstrated, that it is safe to assume that the much more expensive tramway system will not be extended to any great extent.

Notwithstanding this great capacity for handling traffic possessed by the most modern omnibuses

* The Institution of Civil Engineers, the "James Forrest" Lecture, 1922.—Abridged.

mainly for dealing with very short distance traffic, the extension of railway facilities for London is an urgent necessity. The capacity of a train carrying 400 to 500 people, with such trains succeeding one another at intervals of about 1½ minute, is required to deal with the rush of travellers morning and evening, most of whom are showing more and more desire to get well out of London, encouraged thereto by frequent and well-lighted trains, so that they forget the minutes of travel when reading their evening papers.

Another diagram indicated the points where the greatest densities of traffic were to be found in London, rectangulars hatched with hard and fine lines being employed to show trade vehicles and passenger vehicles respectively. From the diagram it appears that the Tower Bridge is almost wholly occupied with trade vehicles, while Westminster Bridge takes the largest proportion of passenger vehicles. Sir John remarked that the traffic over the old Southwark Bridge showed how the old gradients reduced the flow, and that the density over Blackfriars Bridge indicated the necessity for proceeding with St. Paul's Bridge, which has been postponed so often.

We have, continued Sir John, repeatedly seen great objection raised in the Press, mainly on architectural lines, to the continued existence of certain railway bridges across the Thames. It is sometimes forgotten that the number of people who are carried across them in trains in twenty-four hours far exceeds the number of those who could pass over an ordinary road bridge. The objection to them on account of unsightliness is a legitimate complaint capable of being got rid of, but their abolition would be a very distinct loss to the travelling public. Charing Cross railway bridge, for example, has been the butt for much satirical comment, and the company that owns it has been subjected to many stringent regulations should it endeavour to improve it for traffic purposes. There is, however, a plan which has not yet reached the public eye, by which it seems possible to satisfy æsthetic taste, to provide for road requirements, and still enable a bridge to be used for railway purposes. A well-known engineer has shown how a double-decked bridge can be constructed with all those architectural features with which our architect friends desire to ornament the creation of the engineer. In this proposition the railways can be allowed to cross at the same level as now, and thus not interfere with the water-borne traffic on the Thames, while the roadways carried at a higher level are designed to descend with easy gradients so as to join up with the Strand and also with roads on the Surrey side.

There is little doubt that, if the great grouping of railways which is taking place could have been foreseen, Waterloo Station, which is undoubtedly the finest station in London, would not have been built exactly in the present position. As the London and South-Western Railway, the South-Eastern and Chatham Railway, and the Brighton Railway are to form one group, there are certain services of trains from each of these systems which could, with advantage, have been run into Waterloo by making a series of junctions outside, which are not difficult to arrange. Possibly Waterloo Station could even now be made the point of departure and arrival for continental services from the three systems, provided that the electric services now running into the station were found accommodation elsewhere.

### Main Line Railways.

A very great change has come over the railway system of this country since the war, and it is common knowledge that by the end of this year all the railways will have been united by law into four great groups. The general idea of grouping has been that economies may result, and very great expectations have been raised as to the magnitude of these possible economies.

It must, however, be remembered that the labour costs, both in relation to time worked and wages paid, have soared to a height which no one could have anticipated. Before the war railway wages cost £47,000,000 per annum. Since the decreases in time and the increase in pay which were given by the Government the costs rose to £165,000,000 in January, 1921. It is true that under a sliding scale governed by the cost of living there have been reductions of pay which mean £25,000,000 in the aggregate, but the gross figure of expenditure is so much above pre-war times as to jeopardise an early return to a reasonable dividend-producing basis. Added to all this comes the additional cost of coal and the higher prices of nearly all materials when compared with 1913, which is estimated at about £60,000,000.

There are still, therefore, some stupendous figures on the wrong side which exist ready to swallow up most, if not all, of the economies which it is possible to create, before the time arrives when the charges to railway users can be so reduced as to make a substantial difference in the cost of carriage in this country.

The interesting thing, however, to engineers is to see how far it is possible for them to assist in producing economies, and whether these in the aggregate are likely to save such large sums as to affect materially the serious increases I have mentioned. Selecting a recent return (No. 24) for the month of November, 1921, we find that the average length of haul was 55.6 miles, which is a good indication of the short distances we run in our small country. This figure is an average of both general merchandise and minerals, including coal and coke, though if general merchandise is taken alone the figure becomes 88.69 miles. The average freight train load works out to 126 tons, which looks exceedingly small when we are aware of the numerous trains on many English railways which have train loads of from 1000 to 1200 tons. The low figure merely indicates how any average which brings in railways, great and small, does not show the real progress which has taken place. The advent of more powerful locomotives, whether steam or electric, and better wagon loading would have a material effect in increasing this figure. In handling this freight service, all steam locomotives consumed an average of 63.15 lb. of coal per freight engine mile, while the passenger service took 49.64 lb. per passenger engine mile. The above coal consumption shows also what work the 24,373 steam locomotives have been doing on the 51,315 miles of single track, including sidings, in Great Britain. It will be observed that these figures mean that there is about one locomotive to each two miles of single track. The steam locomotive mileage run per day for all locomotives per engine in use as distinguished from the number of engines in stock is in the case of one company 117.76 miles per day, and while five others exceed 100 miles per day, the majority run but slightly over 90.

Interesting as these last figures are, they become more so when we find in another return that the same company which obtains the largest daily mileage out of its steam locomotives, the 117.76 referred to above, also obtains the large week-day mileage of 211.57 miles out of its electric motors, which are attached to its multiple unit trains, while other companies other than the tubes obtain 198.56, 177.61, 167.66, and 167.34 miles. This becomes at once a very practical illustration of the immense advantage of electrical operation which enables you almost to double the work of the mechanical unit, because the electric machine does not require those stoppages for changing engines or for coal and water and cleaning fires which are essential for the steam machine, and, provided lubrication is attended to the electric machine, can go on running for a great length of time if relays of men are provided.

All the points in favour of electrification have been so often put before the public that it would be mere repetition to deal with them again, but I think I may again call attention to the most important fact that the train capacity of any railway and particularly of any terminal station is vastly increased, and thus the capital cost of extensions and widenings can be postponed for many years. One of the advantages of hauling express trains of considerable speed with electric locomotives is that extreme variations of speed are avoided. Where the first part of the journey starts on a heavy gradient the speed will be much higher than with steam, while the necessity for running down grade at high speed will be avoided and a better average speed obtained with little difficulty. The very fact of getting away from terminals rapidly will assist in clearing the line at a point where generally the congestion is greatest. In many cases electrification will cost much less money than widening.

The Government having accepted the report of the Electric Railway Advisory Committee (1921), that future electrification of railways should be carried out with a system of continuous current at 1500 volts, and having set out the information which should govern the position of conductors, one important reason for delay has been swept away.

No one now questions the great advantages of the electrification of suburban railways, but there is still hesitation and doubt as to the extension of electric working to main line traffic. I have no hesitation in saying, in the light of the most modern experience, that there are numerous cases in this country, if the district is carefully selected, where expenditure under this head would be found most remunerative, especially for goods trains, and it is a matter for regret that we move so slowly.

### Wagon Loads and Shunting.

Turning again to the statistical returns, we find that the average wagon load which is given for cases of sixteen companies, shows at once how the loading in each district is affected by the question as to what are the proportions of general merchandise and mineral traffic, the latter always leading to heavier loading. We find one company, which is a large carrier of coal and coke from Yorkshire to the extent of 68.56 per cent. of its tonnage, having only 17.24 per cent. of general merchandise in addition to some other mineral traffic, obtains an average wagon load of 6.41 tons only, whereas when we get to South Wales, where one company has 90.81 per cent. of coal and coke traffic, the average wagon load is 10.28 tons. It is on this coal traffic, with its small loading compared with other nations that we want a quick revolution.

For the first time in the history of British railways the statistical returns enable us to see what is the shunting mileage of the railways as a whole, and you can grasp what a very large item of expenditure this represents.

Selecting twelve consecutive months, we find that 288,000,000 freight engine miles were run in Great Britain, and that out of this 144,000,000 miles, or 50 per cent., were train miles representing remunerative work. Out of the other 50 per cent. no less than 117,000,000 miles were spent in shunting. The basis on which the returns are made up assumes 5 miles an hour for shunting work. This 5 miles an hour is made use of in sorting out and arranging all wagons, both railway-owned and privately-owned, and as the latter form about 50 per cent. of the total, they require about half of the work done. As the all-round cost of a locomotive now works out at about 10s. an hour, £14,250,000 represents the cost of freight shunting, and forms about 20 per cent. of the total locomotive expenditure for running and repairs and renewals in this country.

The ultimate ownership of all wagons by the railway companies, added to the introduction of larger wagons, will eliminate a very large proportion of this shunting expenditure. The constant sorting and arrangement of the 614,127 traders' wagons, which have daily to be sent back to destinations ordered by the 6450 separate people who own them, is like the perpetual piecing together of a jig-saw puzzle with all the disadvantages of wasted work. I consider that it is more than likely that when, in course of time, railway wagon ownership is completed by the railways, from 20 to 25 per cent. of the above large shunting costs will be saved, and that if each succeeding year sees the disappearance of, say, 26,000 to 30,000 private owners' wagons, a proportionate saving will be made.

The effect of grouping so many railways into each group will be that automatically, in course of time, there will be marked tendency to reduce the number of types of locomotives, and immense strides will be made in reducing the number of parts, bringing about that interchangeability which has such a material effect on the economy of upkeep. With regard to wagon stock, the same influences will be brought to bear, and fortunately there is already even before grouping has become effective a marked tendency to have all wagon details constructed to standard patterns. Concentration of workshops will help the railway companies to reduce expenditure, and this applies whether they are concerned with locomotives, carriages, or wagons. The experience in the past has been that where numerous workshops existed on the same railway, the work has not been done with the same economy or the same care in the consumption of stores.

To the economies the railways themselves can effect, ought to be added relief from some of the burdens which they now bear. In 1921 twenty-four of the British railways contributed nearly £11,055,408 in the form of rates and taxes, and a large proportion of this was expended in the maintenance of roads, which in many cases the railway companies do not themselves use. In fact, there are many country districts through which railways run but have no stations, and no necessity for road user, where they pay anything from 5 to 90 per cent. to parish rates, and are thus maintaining the roads which are being used more and more by the competitive road motor traffic which escapes all such local charges, while the railways have to pay something in the way of rates on every yard of their own track and pay the cost of its maintenance as well. These serious charges form a great tax on transport.

Seeing that the sums paid by the railway companies towards local road maintenance are so high, they may find if they carry out large projects of road traction themselves that their equitable demand for a revision of local taxation will be rendered unreasonable, if they themselves add largely to the wear and tear of roads. A remission of local taxtion might turn out in the case of some railways, and in some localities, to be a more profitable thing than any net increase which they might have gained by road haulage.

It is not merely a question of the high figures which the railways pay to-day, but the rapid growth of road traction will inevitably lead to much higher charges, as taxation in some form for the maintenance of roads is not likely to grow less.

### Coal Shipment.

Quite the largest saving which could be brought about quickly is in the carriage and manipulation of export bunker and coastwise coal. This important point is, however, by no means one which can be decided and dealt with by the railway companies alone. It will require the co-operation of the coal owner, the railways, the dock owner and the ship owner, and so great is the possible economy that the sooner these four sets of people get together in conference to see what can be done the sooner will they save those large sums which will result from a proper treatment of a subject which has been too long neglected, but as to which the vital export coal trade of this country demands a common-sense settlement.

The railways themselves use about 13,000,000 tons of coal per annum, and only a very small proportion of this is carried in large wagons. Further, when the coal has to be handled in loading it on the locomotive tenders, it is mainly dealt with by hand. Here are two cases where large daily economies can be effected, first, by carrying coal in larger units, and, secondly, by the use of mechanical coaling appliances.

### Continuous Brakes for Goods Trains.

After some remarks concerning the early history of continuous brakes Sir John went on to say:—

To-day we may, in the case of a passenger train, require brake control to moderate the speed of a train

weighing 500 tons, and this is effectively done in a much more rapid way by fluid pressure brakes, and I hope before long to find that our heaviest goods trains, which at present are about 1200 tons behind the engine, are effectively braked.

This naturally brings one to consider the question of wagon couplings, as in some recently described experiments screw couplings were used, whereas the ordinary three-link coupling allows so much slack that no really rapid application of a continuous brake is possible without serious risk of broken couplings and other damage. As the three-link coupling is already recognised as being one of the things which stands in the way of heavier loading of trains in this country, it will not be surprising to find that some attempt is made to introduce a central buffing coupler with the minimum of possible slack. This is one of those things which has been so long discussed, but so often postponed, and becomes the more necessary when you have efficient brakes. This would in time involve the abolition of the side buffers, which no one would regret. These rolling stock changes, however, must perforce take many years to accomplish, for financial reasons, as it is not likely that they could be dealt with in a wholesale way, but would have to coincide with the re-building of wagon stock, which in ordinary times proceeds for all purposes at about 1000 wagons a week, if a twenty-five years' life is accepted as the average, and it will be recognised that until all wagon stock was fitted, none of the existing couplings or buffers could be removed. Agreement amongst the owners for this continuous policy of alteration would have to be reached with a very full knowledge of all the technical difficulties.

### Supply of Electric Current.

There were at one time great hopes that the supply of electric power for traction and other purposes would be much cheapened if available water power was made use of, but recently the Water Power Resources Committee have told us how much power we may expect to obtain in Great Britain if the most prominent sources of supply are made use of, but while they are able to point out that they might develop 250,000 kilowatts (continuous) per annum, it is quite evident that the geographical position of these supplies will really only benefit certain localities, and that for traction purposes we must still rely largely on coal. It is remarkable that England only contributes power for 20,440 kilowatts, Wales 35,900 kilowatts, and Scotland 194,965 kilowatts. We cannot therefore look forward to any great reduction in cost of current for traction purposes from this source, when speaking of the whole position, and noting the uneven distribution of water power.

On the other hand, the co-ordination of electricity supply which is slowly but surely going on under the guidance of the Electricity Commissioners will before long lead to a supply of current to country districts being a possibility which may lead to a re-birth of local industries; if current can be sold at reasonable prices we may see the great extension of the use of the trolley omnibus for passenger traffic in preference to the petrol-driven machine, and, in addition, a new use of the motor lorry electrically driven taking its current from the same overhead wires.

It is quite true that the trackless trolley system has not made as rapid progress as was expected, and this is indicated by the fact that in 1919 (the latest year for which figures are given), the total number of car miles was slightly under a million, but it is a system of much promise, and has been remarkably free from accident. It appears to be much more likely that the extension of the electrical operation along main roads by means of trolley vehicles will be of value to local industries than any possibility of the extension of light railways.

### Canals.

As to the merits of canals, about which there is so much vain hope, there seems to be much misunderstanding, and we repeatedly see strong statements made by writers who urge that their renewed use would lead to great economies in transit. The fact, however, which has to be faced is that the days of the small barge canal are gone, and the sooner we set about discovering a good use for these properties the better. Most of the small barge canals can only take 30-ton boats, and the locks measure about 70ft. by 7ft.

The greater canals, like the Manchester Ship Canal, which permit of the passage of large cargo steamers, stand on an entirely different basis. The proposals to make use of the river Trent for sea-going vessels, as far as Nottingham, and similar proposals for dealing with large cargoes, are the only ones worth considering from a financial point of view. One by one the canal companies have been ceasing to carry goods themselves and have become mere toll takers from those few by-traders who find it profitable to carry on some sort of business. The canal companies have been driven to this course because wages and materials are so costly that they can no longer compete with the railways, notwithstanding the fact that railway charges are so much higher than they used to be. The Aire and Calder Canal, which is so often spoken of as a fine example, is an instance of well thought out engineering plans, having been persistently pursued for many years. These plans have produced what is probably the cheapest method of conveying coal from the colliery to the ship that can be found anywhere in the world. The 40-ton boats run right under the colliery screens, the coal falling direct into them. Then they are formed into a train of boats of from twenty-five to thirty, which is hauled by a tug to Goole. The boat train thus carries 1200 tons. Having arrived, each boat goes under a hydraulic tip, which lifts it bodily out of the water, and then tips the coal direct into the ship's hold. Local circumstances no doubt favour this method of treatment, and the level country admits of it, but still it is a good illustration of methods, which have been in existence for many years, of the application of engineering principles to cheapening the cost of transport, and its importance is measured by the fact that in 1913 this canal carried 2,563,067 tons of coal.

As one example of what may be done with some of our disused canals, I may refer to a proposition recently discussed as to the abandonment of a portion of the Chesterfield Canal, which joins the Trent below Gainsborough. It has been proposed to abandon that part which is between Chesterfield and the Norwood tunnel, and make use of it for a road 11 miles long.

Should any parliamentary sanction be given to the conversion of canals into roads for motor and other traffic, one considerable source of revenue will be lost to those canals which, when passing through industrial centres, make a large revenue out of the sale of condensing water used by the various factories on the canal banks, and the factories will have to seek other sources of supply. If any large reservoirs of water be rendered available because the canals cease to require water, one naturally presumes that attempts will be made to conserve this water for power purposes so far as its limited supply will admit.

It should always be remembered that there is no town in England that is more than about 65 miles from the sea, and if railways are to convey anything between coast town and coast town their rates must be regulated by the sea-borne traffic, and even central cities like Birmingham have great advantages from the competition of both eastern and western ports.

### Mails and Aerial Transport.

It would appear that the Government of the present day has serious hope that some form of aeroplane can now be produced which will start away from a very small area of ground, or they would hardly have offered such a large money prize for a successful machine. The possibility of producing a machine of the helicopter type with a positive vertical rise may have an important bearing on the construction of future large buildings. His Majesty's General Post Office might become the real starting place and the landing place of the Postmaster's fleet of aeroplanes, rising from or alighting on a large flat roof. It is easy to imagine that the modern hotel lift will convey the guests upwards to a flat roof, and the passenger for Paris or elsewhere will take his place in the aeroplane as easily as he does now in a taxicab on the street level. For the general public, could not many of the squares of London which now contribute but little to the use or pleasure of the ordinary inhabitants be formed into the starting places of the future flying machines, thus avoiding the loss of time and the inconvenience of having to travel to the outskirts of London before being able to get into an aeroplane? We have recently been told by Sir Henry White-Smith that the cost of carrying a passenger from London to Paris works out at £7 1s., or 7d. per passenger mile, and that carrying goods costs 7¼d. per pound, or 5s. 8½d. per ton per mile. For the more valuable classes of goods this is not a matter of great importance, but the cost per ton-mile must be brought down if any goods of an ordinary character are to be carried.

The possibilities of rapid and commodious transport by air have as yet been barely touched by the successes of the past, and we shall see the advent of great improvements if the engineering talent of to-day is encouraged as it should be. It is a sad fact that we should not even know anything like what we do about it had it not been for the constant experiments during the war and the sacrifice of some of our finest manhood. To depend in future merely upon what our Army or our Navy can do with aviation in times of peace would mean the slowest possible progress, through want of varied opportunity of experiment.

The wonderful position which our nation obtained with regard to shipping came about by the ever-present demands of commerce, calling for the highest speeds, combined with the greatest economy of propulsion. The perpetual vigilance of the navigating officers, combined with the investigating powers of the engineers, led to each possible improvement of the ship, or of the machinery, which they might suggest being seized upon at once by the builder and the owners, as necessary for commercial progress. The progress of the Navy from the structural and the propelling point of view, followed the lessons gained by the mercantile marine, and the builders of our vast commercial fleet were able to give to the fighting ships of the nation the whole benefit of the knowledge which they had gained in the construction and trials of the very much greater fleet of ships of commerce. The same methods of gradual and persistent investigation which have been applied for so many years to the ships of the sea must be hastened and applied to the ships of the air.

For the ships of the air we have hardly any such wide experience to guide our constructors, and it seems only a reasonable precaution that we should give national help to encourage private enterprise to develop and improve this new art, every invention connected with which would be available for our fighting air fleet, and the experience gained would probably cost the nation far less than the limited experiments of Government departments. The wider the circle is spread within which to gain our much-needed knowledge, the greater security we shall obtain in the hour of need.

We require the dual protection of both kind of ships, and we may have to vary somewhat Sir Westcott Abell's definition of sea power where he says: "Sea power is the combination of a healthy commerce and mercantile marine with the military navy which ensures by force of arms such protection as will enable the unarmed vessels to carry out their functions." Such a definition will have to be applied in reference both to the sea and the air.

There will probably be common agreement that at no time in the history of this country has national transport been so intimately connected with the necessities of national defence.

## The International Railway Congress.

No. II.*

When Section II. reopened on Monday, the 24th, it was decided to close the discussion on electric traction at noon and to proceed with a consideration of the reports on the economic production and use of steam in locomotives. In Section I. the reports on the maintenance and supervision of the track were concluded, and those on special steels for the track and track work were begun. Thus were the mornings of Monday, Tuesday, Wednesday, and Thursday spent, and in the afternoons of Wednesday and Thursday general meetings of the delegates considered the decisions of the sections. On the morning of Friday, the 28th, the closing ceremonies were held, and it was decided, on the invitation of the Spanish Government, to hold the tenth congress in Madrid in 1927.

The delegates left Rome on the afternoon of the 28th to spend the week-end in Naples, whence they proceeded to Genoa, arriving there on Tuesday afternoon last. On Wednesday, there were inspections of the electrifications in the neighbourhood and of the port of Genoa.

On the afternoon of Friday, April 21st, a special train conveyed a large party of the members of the Railway Conference to the San Lorenzo engine sheds—the locomotive depôt for Rome. Sheds Nos. 16 and 38 are both circular. The former has thirty-two full-length engine standing roads, twenty-five of which have pits, and three shorter roads. It can be entered from any one of seven roads on the south side and there is a single road on the south-west and one leading to the shops on the north side. An engine turntable of 21 m. diameter gives access to or from any road. Shed No. 38 is to the north of No. 16. It has thirty-eight full-length roads, all provided with pits. There is an entrance on the south-east and another on the north-east and two on the north sides, also one from the shops. There are three wheel drops and a turntable of the same dimensions as that in No. 16 shed. Needless to say, the sheds are of reinforced concrete construction. The visitors saw a 2-8-0 engine with an eight-wheeled tender turned by pneumatic power. The compressor was coupled to the Westinghouse train pipe on the front of the engine, and so the locomotive provided its own power for turning. For engines out of steam the compressor obtains air from a main.

An inspection was made of the system of discharging, washing and re-filling of locomotive boilers of Messrs. Guiseppe de Michelli and Co., of Florence, and of a new valve gear designed by Mr. Arturo Caprotti, of Milan, and fitted to 2-8-0 engine No. 740,324.

On Saturday, the 22nd, an excursion was made to Terni to see the hydro-electric station. An excellent luncheon was provided in the mess-room at the steel works, but the weather conditions prevented a visit being paid to the works themselves. The power station, pipe line, calcium carbide works, and demonstrations with liquid air were seen, followed by a visit to the Falls of Marmore. A most enjoyable day concluded by the return from Terni at 6 p.m. It may be mentioned incidentally that high appreciation was expressed on all sides at the excellent rolling stock on the special train and the courtesy on this and every occasion of the Italian State Railway officials.

On Monday, the 24th, at 2 p.m., and again at 4 p.m., the testing rooms of the Railway Administration were visited.

A report from Melbourne states that an automatic motor car rear signal has been invented by an Australian named Bracewell. The device is fixed to the rear of a motor car, and is operated by the steering gear as the car starts on the turn. White arrows, electrically operated, give notice to following drivers of the intended movements of the car carrying the device. At night the arrows are illuminated.

* No. I. appeared April 28th.

# An Account of Some Experiments on the Action of Cutting Tools.*

By Professor E. G. COKER, M.A., D.Sc., F.R.S., and K. C. CHAKKO, D.Sc.

*Introduction.*—The mode of action of cutting tools has been the subject of much investigation on account of its great importance to mechanical engineers, who carry out a very large proportion of their work by aid of machinery designed to provide the most efficient action of various tools for shaping metals and other materials, but so far it has apparently not been studied by photo-elastic methods. As a preliminary to the description of some experiments which have been made by aid of polarised light at the suggestion of the Cutting Tools Research Committee, it may be of interest to recall, very briefly, the principles upon which such experiments are based.

Nearly all transparent bodies when loaded become doubly refractive, and a ray of ordinary light passing through the material in a state of stress is subjected to a selective retardation, whereby its transverse vibrations lag one behind the other. No effect is visible to the eye, since ordinary light consists of such a complex system of transverse vibrations that the eye is unable to detect what is going on, but if ordinary light is, as it were, strained through some kind of sieve whereby a homogeneous character of a particular kind is imparted to it, the effect of stress in the material becomes apparent. The most convenient apparatus for obtaining the homogeneous light mentioned above is a crystal of transparent calcium carbonate, cut in a special way, invented by an Edinburgh optician, William Nicol. Ordinary light, after passing through such a crystal, is found to execute its transverse vibrations in one special plane, and this unilateral kind of light is usually called polarised light, and although this is not a very happily chosen designation, yet it seems to be so firmly established that it is hardly possible now to replace this term by a more appropriate one.

If a stressed body is placed between a pair of Nicol's prisms and a beam of light is passed through the combination, colour effects are observed, which are due to the fact that the plane polarised light from the first prism is broken up by the stressed material into two sets of plane vibrations of light, which travel at different velocities through the material. Not only do these two systems of waves travel at different velocities, but they vibrate in planes at right angles to one another. The function of the second prism is to select components in some definite plane from these two systems, so that these latter will interfere with one another. Interference between two sets of light waves in the same plane is visible to the eye, when the light passing through the object under stress is projected on to a screen, and if white light is used, brilliant colours of rainbow pattern appear, and indicate in a particular manner, to be described later, the stress in the material which the light has passed through. It is owing to this effect that an optical analysis of stress distribution in a transparent body is possible.

*Principal Stresses.*—Turning to the condition of the stressed body itself, it will be convenient to consider this as a plate loaded by forces acting in its plane, since in all the work considered here, only this kind of loading will be met with. If the most complicated kind of loading is imposed on a plate of any form whatever, subject to this condition, some kind of stress distribution is obtained, which, however complicated it may be, has certain characteristic properties of a very simple kind. The most important of these may perhaps be illustrated most easily by reference to an example drawn from the case of a disc, the edge of which is being turned up in a lathe, as shown in Fig. 1. Select any point A in that disc which has a definite and invariable position with regard to the point D of the lathe tool, and imagine a small square placed centrally over the point A, as shown. If this square is set in one particular position, it is capable of proof, as

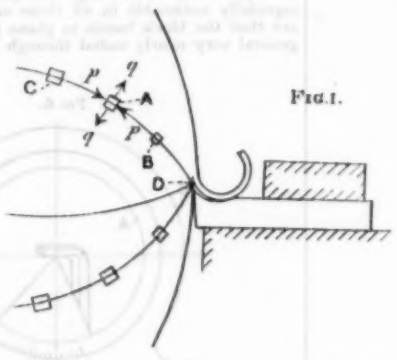



FIG. 1.

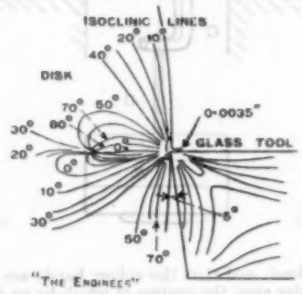



FIG. 2B.

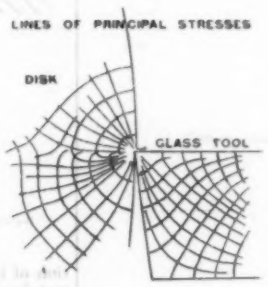
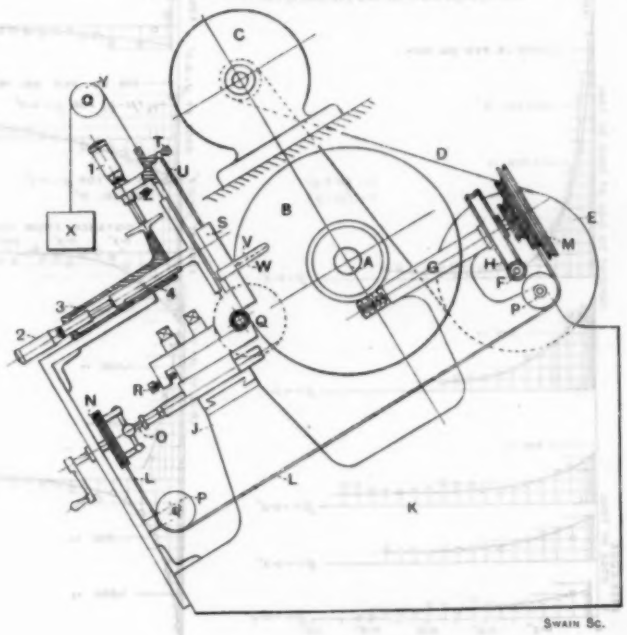



FIG. 2C.

FIG. 3.—*Diagram of Experimental Apparatus for Investigating the Action of Cutting Tools.*




* The Institution of Mechanical Engineers.—Condensed.

that the indications of stress intensity are not dependent on the angular rotation. A set of lines marking the centres of these black bands is shown in Fig. 2B, and the inclination of the stress in both work and glass tool are marked thereon.

This information with regard to directions of stress is complete, since every part of both tool and work is swept over by the black bands during the rotation of the prisms. For convenience, however, it is generally preferable to show this information in a different manner by lines which run along the direction of principal stress. Some of these are shown in Fig. 2C and are derived from the black bands by a simple geometrical process.

The effects of stress in both disc and glass tool are shown in the colour photograph, Fig. 2A,* of a light cut being taken from the disc.

*Stress Intensity.*—The intensities of the principal stresses at each point must now be considered, and the salient fact, which has to be borne in mind in regard to them, is that the colour effect obtained depends on the value of the difference of their intensities at a point. If, for example, $p$ (at A), Fig. 1, has an intensity of 1500 lb. per square inch in compression, and $q$ has an intensity of 500 lb. per square inch, also in compression, the resulting colour indicates 1000 lb. per square inch, as measured by a comparison member subjected to simple tension or compression stress. If, however, the latter stress $q$ is 500 lb. per square inch in tension, the colour effect is found to be proportional to 2000 lb. per square inch, and in any case which can possibly arise it is true to say that colour effect is proportional to $p - q$. A band of colour of the same tint throughout, therefore, indicates that along it $p - q$ has a constant value, and this latter value is measured most conveniently by comparing it with a tension member subjected to such a pull that both colours are exactly matched, for then the stress in the tension member measures $(p - q)$ exactly. For some purposes this may give all the information required, but in general it does not do so, and a way has to be found to separate $p$ from $q$ at every point.

Before describing a method of carrying this out, it is of interest to observe that the law of colour effect is such that a black band or an area may occur which has nothing to do with the direction of stress, since if $(p - q)$ happens to be zero, at any place the field of view will be dark there, but when such places occur they are easily distinguishable, since they remain fixed when the prisms are rotated, while the directional black bands do not. Hence there is no difficulty in practice in assigning a meaning to a stationary black part of the field; it is, in fact, to be regarded as a part of the fixed colour scheme which the forces acting on the body have imposed upon it.

In order to understand the method used here for separating the stress $q$ from $p$, it is necessary again to consider a simple square of the material under stress, such as occurs at any point—say A, Fig. 1. Under the action of one principal stress the square changes in thickness by a definite amount, and if it were the only stress the change of thickness would be exactly the same as occurs on a simple tension member cut from the same plate and under the same stress. In general, the little square is also subjected to stresses $q$ in a direction perpendicular to the stresses $p$, and if both are like, the change of thickness will be larger than before and be proportional to $(p + q)$. If they are unlike, the change of thickness will be smaller; but in any event its magnitude remains proportional to $(p + q)$, and can be expressed in terms of the stress in a simple tension member.

These changes of thickness are required, in general, wherever colour stress values are measured, and it is clear that if the sum and the difference of $p$ and $q$ are obtained, it is merely a simple addition or subtraction sum to separate them.

The actual measurements are performed by a very delicate extensometer, which is moved over the body to measure these changes wherever required, and in the present experiments the observations show that although the body under observation is continually moving, there is no serious difficulty from this cause.

*Experimental Apparatus.*—Having now described the general principles on which this photo-elastic investigation is based, some attention may now be devoted to the problem in hand, namely, the study of the action of cutting tools by this method. It was a matter of some difficulty to decide upon the most appropriate course to take as a commencement, since there are so many forms of cutting tools and a great variety of ways in which they are applied in machines for planing, drilling, turning, milling and the like. As a general rule, it is nearly always best to take the simplest example of an experimental problem and work up to the more complex cases by stages. From this point of view, the action of a planing or shaping tool seemed to offer the most appropriate form of experiment to start with, since such a cutting process is probably simple, as compared with the others mentioned above and the edge is a straight line. It is, however, open to the objection that the cutting action cannot be carried on continuously, and is therefore not so suitable for observation as others in which there is no break in the cutting process. Turning operations offer much more chance of obtaining long-continued observations, and it was therefore decided to construct a simple form of lathe, which would enable the action of both work and tool to be observed in the polariscope.

An experimental apparatus was therefore constructed, and after some alterations, which experience in early trials suggested, it took a form substantially as shown in the diagrammatic representation—Fig. 3—in which a spindle A, carrying a transparent disc B, is driven from a motor C by a band D wrapped round a pulley E on a first-motion shaft F, which latter drives a second-motion shaft G by a worm wheel gear H. The second-motion shaft G drives the spindle A by a further worm wheel drive, as shown, thus ensuring a very steady and slow drive for convenience of the photo-elastic measurements. In order to obtain a considerable range of speed variation,

* Figs. 2A, 4A, 4B and 15C are colour photographs and are not reproduced. They were shown at the meeting as lantern slides, and will be included in the "Proceedings" when published.—ED. THE E.

the pulleys have several steps, also the speed of the motor can be varied. A small slide rest J, of the usual pattern, is mounted on the frame K of the machine, and the lower slide is actuated from the second-motion shaft by an endless leather belt L, which latter passes over a coned pulley M on the second-motion shaft, and over a pulley N secured to the feed screw O of the lower slide. Guide pulleys P are provided to permit this motion, and to give enough tension in the belt to ensure a uniform radial feed. In practice, this was satisfactorily obtained. The tool Q is secured in the ordinary way, and a steadying screw R, pressing against the end of the tool, prevents radial slip. The whole arrangement is devised to permit the passage of a beam of light through the disc and through the glass tool when the cutting action is in progress. The stress distribution in both can then be studied by aid of the coloured bands which appear in both the work and the tool.

The colour photograph—Fig. 4A—shows the general features of interest observed in a disc under the action of a steel cutting tool, the edge of which has been carefully set on a stone, and it will be noted that above the tool there are coloured bands which appear to spring from a point close to the cutting edge, and to curve round towards the boundary above the tool in approximately circular arcs. Below there are a second set of coloured bands much more limited in extent, springing from near the point of the tool, and forming approximate circular arcs which meet the boundary below. These two systems are separated by a black band or brush which varies somewhat in position with the speed of cutting, and with the principal angles of the cutting tool. It is also worthy of note that very near to the point of the tool, an intensely black spot is found, which varies slightly in position according to the running conditions. It forms, in fact, a good qualitative index of the steadiness of the running and of the uniformity of the cutting action. It is of particular interest to note that there is a black patch in the shaving immediately above the tool, which remains stationary in time, but not in position, as, although the shaving is intensely coloured after leaving the tool, the black patch disappears in this case. It does not vanish with a badly ground tool, as will be shown immediately, and some very interesting phenonema are observed which will require much further study for their complete elucidation.

Before proceeding to an analysis of these phenomena, it will be convenient to describe the arrangement of the extensometer for lateral measurements shown in the diagram, Fig. 3. The extensometer available was not constructed to work in a vertical position, although it can be made to do so, and it was, therefore, necessary to tilt the experimental lathe, as shown, so that the frame S of the extensometer could be suspended from a three-point suspension, formed by a spherical ball joint T on the tail rod U, and two wires V carried by extensions W from the slide rest J. The extensometer and slide rest are partially balanced by a weight X, which hangs from a stout thread passing over a pulley Y and attached to the slide Z, and the motion of this latter is controlled by a micrometer screw 1 reading to thousandths of an inch. A second micrometer screw 2 at right angles, in a casing 3 supporting a cross slide 4, serves to adjust the radial position of the extensometer. The arrangement, in fact, permits of the extensometer being brought to any position with reference to a pair of rectangular co-ordinates perpendicular and tangential to the disc periphery, for measurement. It can also be used for determining the lateral change in the tool, although this has not been done up to the time this report was presented, and, as will appear later, it seems possible that this latter measurement may not be necessary.

*The Stress Distribution in a Disc caused by the Action of a Turning Tool.*—The general appearance, in polarised light, of a disc under the action of a cutting tool, has already been described very briefly for a tool with a very sharp edge, but if the conditions are varied there are some notable differences which may be suitably described here. A tool with an edge finished by grinding in the usual way, and an angle of from 45 deg. to 60 deg., produces an action quite different from one with a similar edge, but finished on a stone as perfectly as possible. In the former case, the cutting action is very imperfect, and the material is broken away from the disc by a wedge action in which apparently the shaving is bent away from the disc by the upper face of the tool, and is torn off with little or no true cutting action. This is accompanied by notable changes in the colour effects, which follow a cyclo pulsating about a mean position. The shaving also presents a series of light and dark patches corresponding to these cyclic changes—as shown in the colour photograph, Fig. 4B. The edge of the disc is left in a ragged condition and somewhat wavy in outline, so much so, in fact, that in some cases the main shaving broken off in this way is accompanied by a very thin shaving quite separate from the main one, and pared off by a true cutting process. A similar effect, in metals, has been noted by other members of this Committee. That it is possible to obtain a somewhat similar effect in the turning of cast iron is well known, only in this case the cast iron chippings are accompanied by a fine powder of cast iron falling from the cutting edge of the tool.

Another interesting matter to which attention may be drawn is the effect of change of speed when a sufficiently sharp and properly formed cutting tool is used, so that colour pulsations are avoided. With a uniform cut of, say, 0.02in. on a 6in. disc, the colour effects appear to be quite constant over a considerable range of speed, but as even the maximum speed of this experimental apparatus is very low, say, one turn in thirty seconds, it is not possible to infer that this unchanging appearance of the colour bands would always be maintained. So far as the experiments have been carried, it appears to be true that the stress distribution remains invariable over a limited range of speed; therefore, the total work done is a linear function of the speed. Putting this in another way, it may be said that the work required to remove a given weight of nitro-cellulose is a constant within the limits of these experiments.

The measurements of the stresses in the neighbourhood of the tool were not found to present any great difficulty, and although some had been expected when measuring the sum of the principal stresses with a moving disc, yet they proved to be rather easier to measure than the difference values from the colour phenomena, especially at low stresses. These measurements are conveniently described with reference to the stress distribution found in a 6in. disc subjected to the action of a tool with a cutting angle of 45 deg. when removing a shaving of 0.015in. thickness. These observations are plotted in Fig. 5A for a number of sections parallel to a radial line passing through the centre of the cutting edge of the tool.

On referring to the first series of these observations, where $y = 0.0$, that is, along the radial line, it will be noticed that the $(p \pm q)$ values are nearly alike throughout the range of possible observation, and that for $y = -0.1$in. and $-0.2$in. there is a similar agreement. Farther away it was only found possible to obtain values of $(p \pm q)$, except over a very limited range, but so far as both series of measurements could be carried, they point to the conclusion that one principal stress $q$ is practically negligible.

If, on the other hand, the sections on the other side of the line are examined for corresponding positions, the reverse effect is noted. $(p - q)$ are now, in general, opposite in sign and approximately equal in magnitude—Fig. 5B—so that the stress is almost wholly of the opposite character, and it seems reasonable to infer that the stress distribution produced by the cutting tool is nearly all pure compression above the black brush separating the two systems of colour bands; and nearly all pure tension below, except in the very small region where plastic deformation is produced, for which the measurements give no definite information.

*The Stress Distribution in the Cutting Tool.*—Early experiments made with a glass-cutting tool—Fig. 2c—seemed to show that the stress system in the tool is possibly of a simple type, such as might be produced approximately by the action of a single force acting at the cutting edge. There is some difficulty in ascertaining completely the distribution of stress at the extreme point of a glass cutting tool in action for several reasons. The optical constant of glass is small and the colour bands are not therefore so readily observable as in nitro-cellulose, while its elastic coefficient E is high. In plate glass, for instance, the value of E as measured* is 10,500,000 lb. per square inch, as compared with, say, 300,000 lb. for nitro-cellulose, while the Poissons' ratios $m = \frac{1}{\sigma}$ are 4.4 and 2.5 respectively. The ratio of $m$ E in the two cases is therefore about 1 to 62, and the lateral changes in glass and nitro-cellulose are also in this ratio. In addition, there is difficulty in keeping the shaving clear of the measuring points of the lateral extensometer when close up to the cutting edge, so that it was considered advisable to attack this part of the problem by an indirect method, using a wedge of nitro-cellulose loaded at its apex by a known force.

For this purpose a wedge with an angle of 60 deg. was secured to a plate A—Fig. 6—consisting of a graduated annular disc of 4in. internal diameter secured in a frame B in such a manner that the wedge could be set in any required angular position in a vertical plane under a dead load W, applied by means of a stirrup C and a hanger D. To prevent local crushing of the material as far as possible, at the apex of the wedge, this was rounded to a curve of small radius.

An investigation of the stress system in such a wedge under load was made, first when the wedge was symmetrically placed with respect to the line of load, and later when moved round through definite angles of 5 deg., 10 deg., 15 deg. and 20 deg. The general optical features, especially noticeable in all these cases when examined, are that the black bands in plane polarised light are in general very nearly radial through the point of application of the load, and that the colour bands are approximately circular arcs, the centres of which lie on a definite line in each case. At the extreme apex, however, when the material passes beyond the elastic range, the colour bands are no longer circular arcs. The stress distribution in this area cannot be examined with any accuracy, since the fundamental laws of its optical and plastic behaviour are not at present known, but it is reasonable to suppose that in a material which remains in an elastic condition right up to the apex, the distribution will be of the same type as that found in the elastic region of a nitro-cellulose model.

Under a symmetrically disposed load, the isoclinic lines are found to be practically radial near the apex, as Fig. 7A shows; while the bands of colour, marking the stress difference intensity, are approximately arcs of circles with centres on the line of load and all passing through the apex. This is shown by the experimental curves of Fig. 7B, which correspond closely to the dotted circles fulfilling the conditions stated above. If, however, the material at the apex becomes plastic, there is a redistribution and equalisation of the stress in the crushed area. The colour bands immediately below are found to be approximately parallel to the line of demarcation between the elastic and plastic material, and for some considerable distance below, the bands are larger in radius, owing to the redistribution effect above.

When the load is slightly unsymmetrical the lines of principal stress in the elastic region appear to remain fairly radial and concentric with the point of application, and the colour bands of stress difference still remain approximately circular arcs with centres lying all on one line passing through the axis, but this line is now inclined at a considerable angle. This is shown by Figs. 8A and 8B, in which the direction of the applied force is inclined at 5 deg., and the experimental curves are easily seen to be of the type described, except for a small area close to the apex. For still greater inclinations of the applied force the same general characteristics are observed, as Figs. 9, 10 and 11 show, and in the two latter cases it is worth noting that a dark radial band appears on the right, indicating no stress in this region, as subsequent

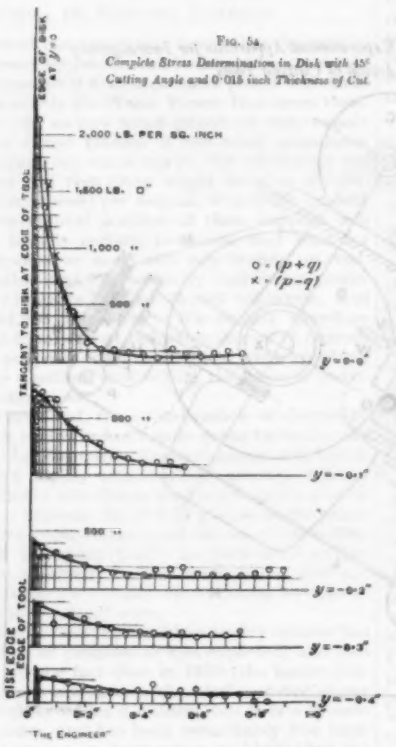



FIG. 5A.

*Complete Stress Determination in Disk with 45° Cutting Angle and 0·015 inch Thickness of Cut.*

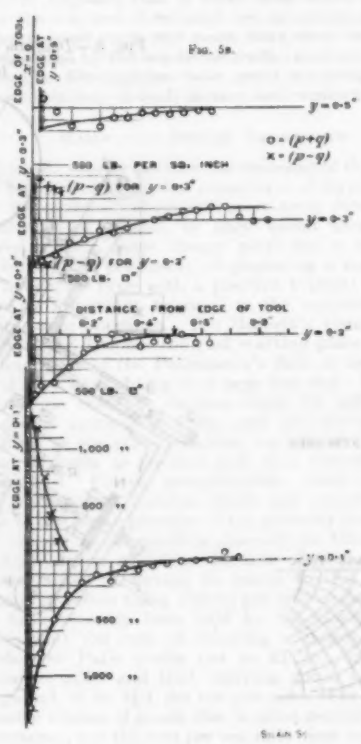



FIG. 5B.

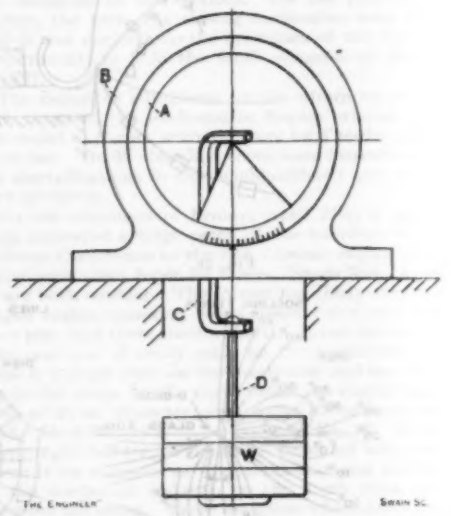
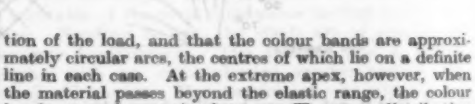



FIG. 6.




* "An Investigation into the Elastic Constants of Rocks, more especially with reference to Cubic Compressibility," by F. D. Adams and E. G. Coker. "Proceedings," Carnegie Institution of Washington. 1906.

# THE CARELS FACTORY AT GHENT

MAIN TURNING SHOP IMMEDIATELY AFTER THE ARMISTICE

MAIN TURNING SHOP ONE YEAR AFTER THE ARMISTICE

LARGE FOUNDRY AT THE TIME OF THE ARMISTICE

LARGE FOUNDRY AT THE PRESENT TIME

LARGE FOUNDRY AT THE TIME OF THE ARMISTICE

LARGE FOUNDRY AT THE PRESENT TIME

LOCOMOTIVE ERECTING SHOP, JUNE, 1920

DRILLING, PLANING AND SLOTTING MACHINES

SMALL MOTOR WINDING DEPARTMENT

SMALL MOTOR ASSEMBLING DEPARTMENT

measurements verify. There is, moreover, reason to suppose in these latter cases that the lines of stress are not quite of the same type as before, since the isoclinic lines are distinctly curved in the neighbourhood of the apex.

The stress effects in a wedge when loaded in this manner are shown in Fig. 15c, in which the specimen is viewed in circularly polarised light, so that only the colour effects are visible and the isoclinics do not appear in the photograph. It will be noted that the extreme point of the wedge has been rendered plastic by the vertical load applied, and is therefore opaque. The colour bands

60° Wedge Isoclinic Lines, Load 80 lb.

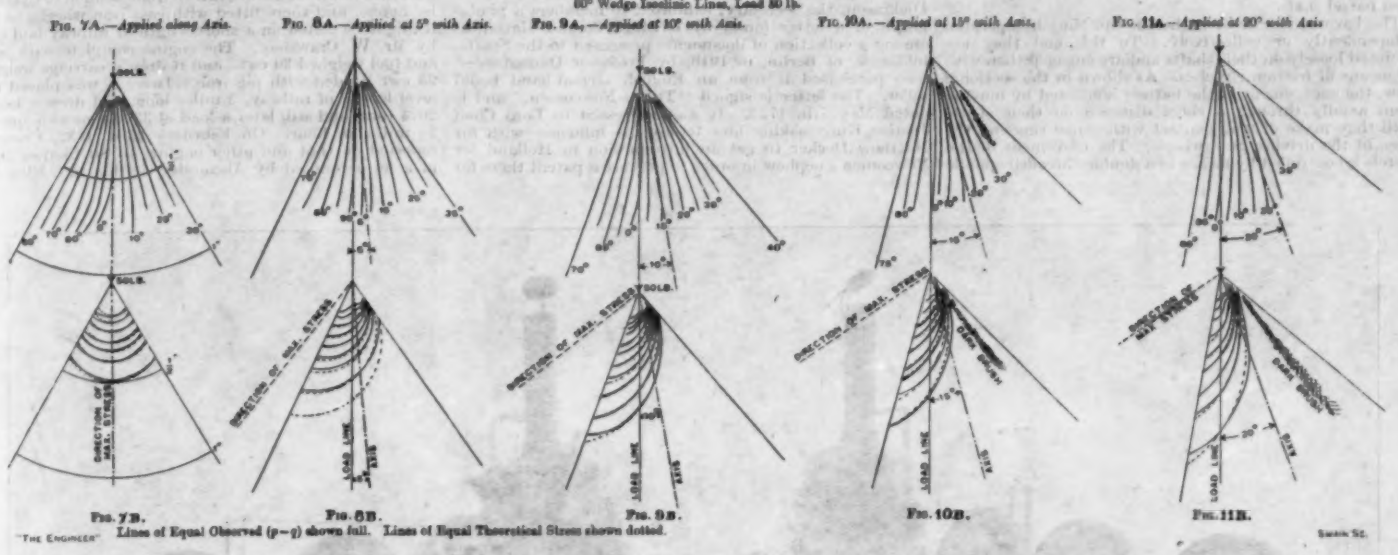


FIG. 7A.—Applied along Axis.
FIG. 8A.—Applied at 5° with Axis.
FIG. 9A.—Applied at 10° with Axis.
FIG. 10A.—Applied at 15° with Axis.
FIG. 11A.—Applied at 20° with Axis.
SOLID.
DIRECTION OF MAX. STRESS
LOAD LINE
FIG. 7B.
FIG. 8B.
FIG. 9B.
FIG. 10B.
FIG. 11B.
"THE ENGINEER"
Lines of Equal Observed (p−q) shown full. Lines of Equal Theoretical Stress shown dotted.

immediately below this region are therefore not circular arcs, since the plastic stress in the material just above causes a change in the loading of the contiguous layer below. Well away from this region, however, the bands resume their circular arc form.

It is possible that the account given here of the distribution of stress in a turned disc may be helpful in forming an idea of the kind of stress which occurs in a cylinder when a cut is taken along it, but it is clear that the stress system so produced is not nearly so simple as in the disc, while in both cases the distribution of stress in the plastic region in the work, the tool and the shaving presents problems of a higher order of difficulty, which the authors venture to suggest as of immediate importance to the Committee.

## Carriage Stock for the Palestine Railway.

THE accompanying illustration represents one of the new railway carriages which are now being supplied to the Palestine Railway by the Metropolitan Carriage, Wagon and Finance Company, Limited. The coaches, which were built at the company's Saltley works, measure 65ft. over the ends by 9ft. 6in. wide outside. The complete order includes first and second-class composite cars, second-class cars and brake vans, all of which are of the same leading dimensions and outward appearance, and have bellows coupling arrangements for through communication. The second-class cars, one of which forms the subject of our illustration, have accommodation for seating seventy-two passengers.

The climatic conditions governed the design of the bodies, which are characterised by the very high sweep of the roof, so as to allow more space than is usual between the outer roof and the ceiling of the compartment, and so as to provide a maximum volume of air within that space. The cars are of the semi-open compartment type in which a longitudinal corridor runs on one side between the end vestibules, and the compartments are separated from each other by partitions reaching to the ceiling, but are entirely open on the corridor side. This arrangement has been adopted because it permits of ample luggage accommodation in overhead racks, ensures security from theft, and more privacy and silence, while at the same time passengers benefit by the increased air space of the corridor. One compartment only in each car is totally enclosed, so as to be reservable for ladies

The bulk of the accommodation provided is for second-class passengers; these compartments are finished in varnished pitch pine, with white millboard ceiling, and upper partitions—the seats being upholstered in rattan cane. The windows are of large size, and are arranged low enough to cut off the glare of the sun, without unduly restricting the sight. In addition to the usual glass frames, venetian blinds and hit-and-miss ventilators are provided, and it is anticipated that they, in conjunction with the high ceilings, will enable the cars to remain cool and airy under the most adverse conditions.

A lavatory is provided at one end of each car. In this connection a difficult point arose out of the different customs of European and Eastern travellers, an open latrine having to be provided for the latter, and the usual wooden hinged seat for the former. Two separate lavatories would normally have been the best solution of the problem; but in this case the makers ingeniously solved it by designing a special fitting embodying a wooden seat which springs out of the way when not in use, and discloses a white enamelled cast iron foot plate of the oriental type.

The first-class compartments have oak panelling, and are fitted with mirrors and electric chandeliers. The first-class lavatories are enamelled white, and are lined with tiles from the floor to the waist rail. In all lavatories the floor is made of Dockers' Induroleum, moulded to a curve where it meets the partitions, so as to facilitate cleaning. A porcelain wash basin, towel rack and basket, coat hooks and mirrors, are provided in every lavatory, and a large water tank is arranged in the roof. Electric light is provided on all cars, the current being generated by a dynamo, and stored in accumulators carried in the underframe.

The underframe, which is of very strong construction, is built up of rolled steel channels, with truss angles and stiffening plates. It is very similar to that supplied by the Metropolitan Carriage, Wagon and Finance Company for the largest carriage stock of the Egyptian Government Railways. Each buffer acts on a volute spring bearing upon the outer headstock, and a helical spring bearing upon the main headstock. The drawbar pull is direct on the bolster girder through india-rubber springs. This combination of buffing and draw springs has proved remarkably satisfactory.

The bogie frames are built of steel plates and angles. The swing bolsters rest upon quadruple elliptical springs, and the main frames are carried by laminated springs resting upon the axle-boxes and fitted with india-rubber auxiliary springs. This type of suspension, in conjunction with the large wheels and long wheel base, should ensure very smooth and steady running.

PALESTINE RAILWAY—SECOND-CLASS CORRIDOR COACH

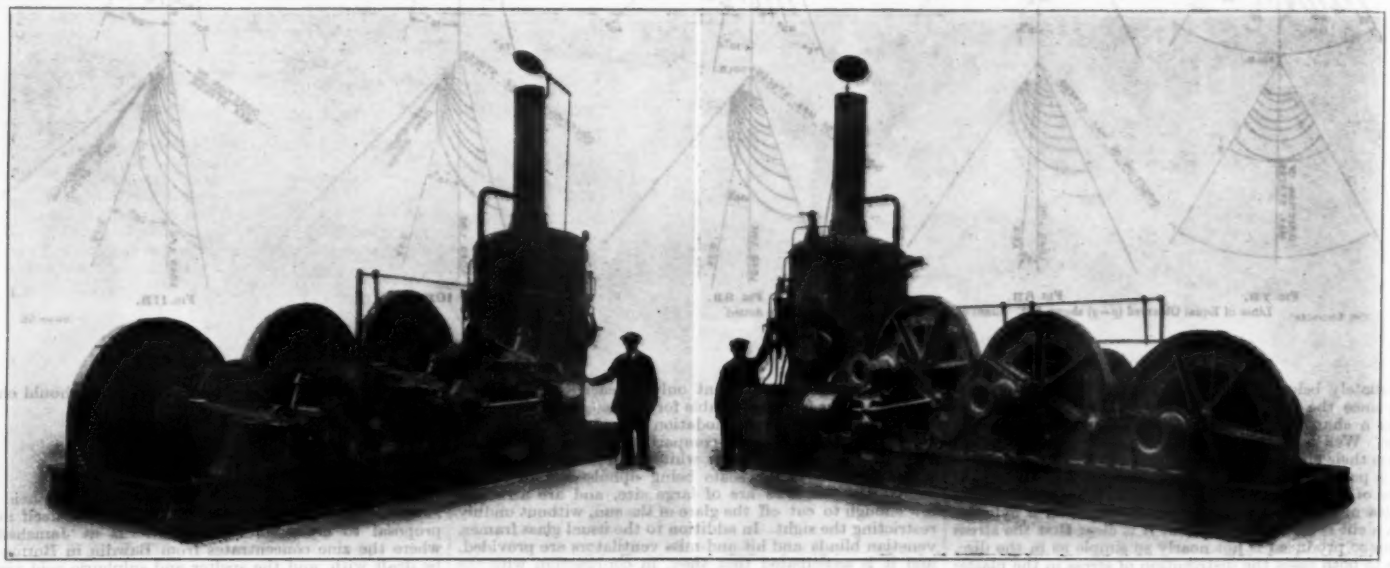
OWING to the importance both of sulphuric acid and zinc, the Government of India is interesting itself in the proposal to erect zinc-smelting works at Jamshedpur, where the zinc concentrates from Bawdin in Burma will be dealt with, and the spelter and sulphuric acid yielded made available to the Tata Iron and Steel Company for its own purposes and for subsidiary companies. The plant, which it is proposed to erect, with a loan from Government, will be capable of dealing with 25,000 tons of zinc concentrates, and the estimated output is 10,000 tons of spelter per annum, and 32,000 tons of sulphuric acid.

INSTITUTION OF NAVAL ARCHITECTS.—A summer meeting of the Institution of Naval Architects will be held in Paris on July 4th to 8th, at the invitation of the president of the Association Technique Maritime (M. Bertin, president of the Académie des Sciences). The following provisional programme, which is subject to revision, has been arranged:—On Tuesday, July 4th, the opening meeting will be held at 10 a.m., in the Amphitheatre of the Sorbonne (University of Paris). His Grace the Duke of Northumberland (president of the Institution) will preside. Papers will be read on the mornings of July 4th, 5th, and 6th, the afternoons being devoted to sightseeing, receptions, and visits to works, &c. In the afternoon of the 4th there will be a reception by M. Bertin. On the 5th and 6th there will be receptions by the Minister of Marine, the Municipal Council, and the Chamber of Commerce; and in the evening of the 5th a dinner will be given by the Institution of Naval Architects. On Friday, the 7th, there will be an all-day excursion to Rheims and the devastated areas in that neighbourhood. A luncheon will be given by the Association Technique Maritime. On Saturday, July 8th, a visit will be paid to the shipyards at Havre and/or Caen, provided a sufficient number of members express a desire to take this journey. Those doing so can return to England via Havre and Southampton.

## A Treble-Drum Friction Winch.

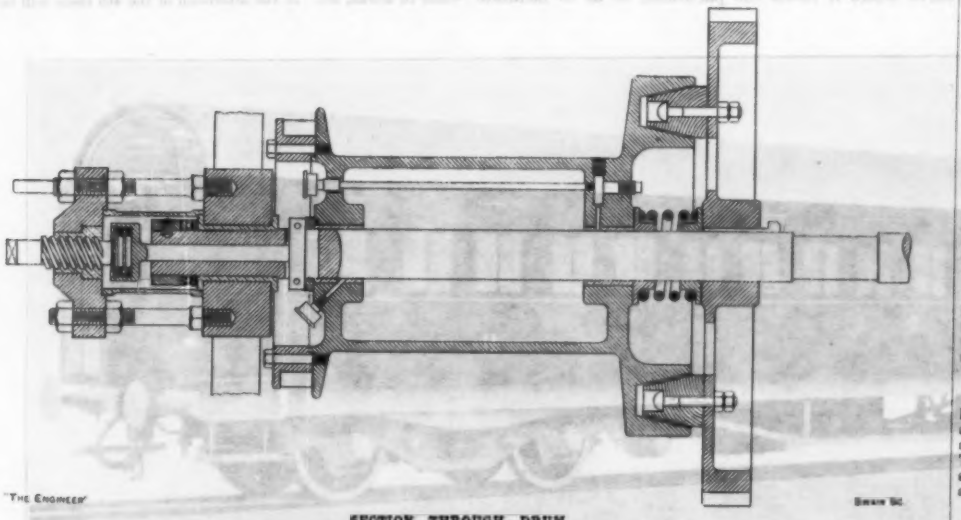
THE 6-ton treble-drum friction winch illustrated herewith has recently been built by the British Steel Piling Company, of London and Claydon, to the order of the Auckland (New Zealand) Harbour Board. The winch is designed to hoist a total load of 6 tons at a speed of 200ft. per minute. This load may be hoisted on one of the barrels alone or distributed among the three barrels. Furthermore, while one or two of the barrels are in use for hoisting purposes a load up to 6 tons may be held suspended on the others or other. In addition to the barrels a constantly rotating warping drum is mounted at the end of each barrel shaft.

The barrels, it will be gathered, can thus be operated independently or collectively. To this end they are mounted loosely on their shafts and are engaged therewith by means of friction clutches. As shown in the sectional view, the engagement of the barrels is effected by moving them axially through a short distance on their shafts until they make driving contact with coned rings on the faces of the driving gear wheels. The movement of the barrels is controlled by means of a double-threaded spindle of winch in four sizes, namely, with capacities of 1¼, 2½, 3, and 6 tons. They are made with one, two, or three barrels, and are claimed to be particularly suitable for pile driving, logging, operating cableways, &c. As an alternative to steam driving, the winches can be made for operation by electric motor or petrol or paraffin engine.



STEAM-DRIVEN TREBLE-DRUM FRICTION WINCH

bearing through a ball-thrust washer against the end of a rod which, passing into a hole bored up the barrel shaft, acts on a key inserted through a slot in the shaft and abutting against the hub of the barrel. The disengagement of the barrel when the screw is released is effected by means of a spiral spring at the opposite end. The axial thrust transmitted from the barrel to the shaft when the clutch is engaged is taken by a ball bearing between the side frame and a collar on the end of the shaft. The two ball bearings and the ends of the shaft, thrust-rod and screw are enclosed in a dust-tight oil bath. The barrels, when disengaged from the drive, are controlled by means of foot-operated band brakes at one end, and by power-




SECTION THROUGH DRUM

engaging ratchet teeth at the other. All the bearings are independently lubricated, tubes being provided where the parts to be attended to are inaccessible.

The power equipment comprises two 9½in. by 12in. cylinders driving a crank axle disposed across the side frames between the first and second barrels. All the pinions and gear wheels have machine-cut teeth, the former being of mild steel and the latter of cast iron. The boiler is of the Spencer-Hopwood patented water-tube type, and has a working pressure of 120 lb. It is fitted with a stop valve combining an anti-priming device and with a quick-action control valve, which may be operated from any position.

The makers inform us that they produce this pattern

## The Newcomen Society.

AT the last meeting of the Newcomen Society, which was held at Caxton Hall, on Thursday, April 27th, four short papers were presented. In the first, Mr. H. W. Dickinson, the secretary, exhibited to members a photograph of a letter found by Dr. Ing. Conrad Matschoss among a collection of documents presented to the Staatsbibliotek, of Berlin, in 1919, by Professor Darmstaedter, who purchased it from an English second-hand bookseller. The letter is signed "Thos: Newcomen," and is dated May 7th, 1725. It was addressed to Lord Chief Justice King, asking him to use his influence with Sir Matthew Decker to get an introduction in Holland for Newcomen's nephew in order to procure a patent there for "our New Invented Wind Engine or Machine." The letter is composed in excellent English, and the handwriting is admirable. The discussion turned upon the ability of Newcomen, a country mechanic, to write such a letter, and it was quite evident that many of the members were not prepared to accept its authenticity—at least as an original document in Newcomen's own handwriting—without further evidence.

In the second note, Mr. L. Pendred dealt with a defect in the design of Brunton's walking engine, as shown in the drawing in his patent specification of 1813. In that drawing no means of guiding the piston-rod are indicated, and Mr. Pendred showed by means of a simple model that owing to the character of the mechanism a considerable upward thrust on the crosshead must have occurred. Turning then to two links shown on the drawing without a word of explanation in the text, he illustrated by means of the model that the addition of a bracket to the back end of the boiler and the attachment of the free ends of these links to it, a straight-line motion of the type subsequently known as the Scott-Russell was formed. He suggested that the bracket was intentionally omitted from the drawing, but Mr. Tennant, in the discussion, put forward the alternative that it might have been left out accidentally by the draughtsman.

The third note was contributed by Mr. Arthur Titley, and dealt with a number of letters and documents connected with the efforts made in 1828 to establish a line of Heaton's steam carriages. Amongst this diversity of papers which are now in the possession of the Dugard family was a printed circular for an Institute of Locomotion, which Mr. Alexander Gordon, the author of "Elemental Locomotion" and many other works, endeavoured to establish. It seems to have been the predecessor of our present Institute of Transport. Nothing is known of its history. The documents Mr. Titley laid before the Society provide an interesting chapter in the history of steam locomotion on common roads.

The last note, written by Mr. E. A. Forward, described Sir Goldsworthy Gurney's railway locomotives, which are much less well known than his road carriages. It appears that in 1830 an engine was drawn from London to Cyfarthfa by horses, and there fitted with cast iron wheels, so that it might be tested on a short length of railway laid down by Mr. W. Crawshay. The engine complete with water and fuel weighed 30 cwt., and it drew a carriage weighing 25 cwt. loaded with pig iron. Later it was placed on a level length of railway, 3 miles long, and drew a load of 20.4 tons, and still later a load of 33.9 tons at a speed of 2½ miles an hour. On February 23rd, 1832, Crawshay reported on that and other engines to Sir Charles Dance in a letter quoted by Alexander Gordon in "Elemental Locomotion." In that report he says: "I consider that the unprecedented depression of the iron trade, and the late disturbances in South Wales, have much impeded the further introduction, use and improvement of locomotive engines in this part of the country."

The meeting was a marked success, and it may be hoped that other evenings may be devoted to similar short papers. The announcement was made that amongst new members of the Society were Monsieur Achard, of Belfort; Mr. A. A. Campbell Swinton; and Mr. Daniel Adamson. A summer meeting of two-days' duration is to be held in London on the first two days of June.

## PERSONAL AND BUSINESS ANNOUNCEMENTS.

MR. HERBERT S. BRUCKSHAW has been appointed a director of the Chatwood Safe Company, Limited, bankers' engineers, Bolton.

MR. F. M. JONES, formerly of the British Thomson-Houston Company, and until lately assistant general manager of Boving and Co., Limited, and Electro-Metals, Limited, has joined the staff of W. H. Allen, Sons and Co., Bedford.

ALFRED HERBERT, Limited, of Coventry, asks us to state that it has entered into an exclusive agency arrangement for the countries of Japan, Manchuria, Korea, and Formosa, for the sale of power presses made by John Hands and Sons, Limited, Birmingham.

THE RAMSAY CONDENSING LOCOMOTIVE COMPANY, Limited, informs us that it has opened an office in Manchester, and requests that in future all letters and communications should be addressed to it at Millgate Buildings, 18, Long Millgate, Manchester. Its registered office will remain the same as heretofore, viz., 105, St. Vincent-street, Glasgow.

ALFRED HERBERT, Limited, Coventry, inform us that they have entered into an arrangement with Carrick Wedderspoon and Co., of Christchurch, New Zealand, whereby that firm will act as Messrs. Herbert's sole selling agents for New Zealand. This arrangement covers all the machines, small tools and accessories which Messrs. Herbert make and for which they hold agencies throughout the world.

JOHN M. HENDERSON AND CO., King's Works, Aberdeen, inform us that they have made arrangements with Mr. F. G. Mitchell, of the Mitchell Conveyor and Transporter Company, Limited, 45–50, Holborn-viaduct, London, E.C. 1, to undertake the manufacture of "Krom" crushers, "Maxecon" mills, and new type "Kent" mills for that company. Messrs. Henderson have also acquired the joint selling rights of these machines.

### ERRATUM.

A FRENCH PETROL LOCOMOTIVE.—In the closing sentence of the second paragraph on page 476 of our last issue, there is an obvious error in the statement that the locomotive was capable of hauling a train of 300 to 350 tons at a speed of 60 kiloms. per hour. The correct figures are given in the table later in the article.

# Provincial Letters.

## THE MIDLANDS AND STAFFORDSHIRE.

*(From our own Correspondent.)*

### A Step in the Right Direction.

THE more hopeful feeling existing in Midland industrial circles and the indications of better trade to which I referred in my letter last week have received a timely fillip this week by the satisfactory nature of the Budget proposals. The reduction of taxation has put new heart into business men, who have been carrying on their businesses under a crushing burden. Much satisfaction was expressed on Birmingham Exchange to-day that the Chancellor had elected to pursue a policy calculated to assist the wheels of industry to begin turning again, and it is on all hands agreed that the Budget will act as a distinct stimulus to trade. By giving aid to the income tax payer, the Chancellor has rendered a real service, not to one class only, but to all. He at once facilitates the accumulation of new capital, available for industrial purposes, and affords encouragement to its investment in productive industry. With a tax of 5s. in the pound instead of 6s., with letter-writing and the postage on circulars and price lists a less costly business, and with the permission now granted to spread payment of E.P.D. arrears over five years, manufacturers will pluck up heart and will again begin to reckon up the possibilities of new enterprise.

### The Lock-out.

Immense harm is being done, just at a time when trade is beginning to show signs of revival, by the continued dispute in the engineering industry. Trade in Coventry would be flourishing at the present moment, as far as its principal industry is concerned, but for this unsettlement, while Birmingham manufacturers and iron and steelmasters consider it the principal deterrent to an expansion of trade. It is agreed that the recently appointed court of inquiry can do no harm, and might do good in assisting to arrive at a settlement of the dispute, but it is realised that the court cannot enforce its findings. Whatever way is found of bringing the matter to an issue, no solution will be lasting unless the employers and the unions lay their heads together to find a basis of agreement founded on mutual trust.

### Encouraging Pig Iron Position.

Business in pig iron continues encouraging, with a steady export trade and generally firm prices. The breakdown of negotiations in connection with the engineering trouble caused some discouragement, especially in view of the growing confidence as to the general outlook. One effect of the lock-out has been the issue of a number of instructions to suspend delivery from the furnaces. This is a matter of some seriousness, in view of the high labour costs in the putting down and lifting of stock. An indirect effect of the lock-out is the postponement of the railway rates revision, on which the managers are understood to have formulated their policy. This has a very important bearing on the question of the re-starting of blast-furnaces. One large Midland company, however, it is stated, has decided to relight an additional furnace, chiefly for the manufacture of foundry iron. It is considered satisfactory that prices are maintained, and that while the production of raw material still keeps small, the output is being disposed of. Buyers are, in fact, taking interest in forward bookings, and in some cases would be glad to place large orders, but the position is so uncertain that few blast-furnacemen will accept large tonnages at present prices. They are of opinion that a buying movement is likely to follow the termination of hostilities in the engineering trade. The trade derives considerable assistance from the healthy state of the export pig iron market, especially at Middlesbrough. In this connection, it is interesting to note that during April Germany became the largest buyer among foreign countries of Cleveland iron. She purchased over 11,000 tons of iron, and further large shipments have been booked. The rising value of share capital is also regarded as a very hopeful feature. The slowing down of buying, it is thought, may in the long run be all to the good of the producer, inasmuch as stocks are running short, and the return of peace will send users on the market. Something like twenty-five out of the thirty Black Country furnaces are still out of commission, and the present output from this district is almost solely for the consumption of allied concerns, while in Northamptonshire not more than a third of the furnaces is in blast.

### Better Call for Nut and Bolt Bars.

Midland ironmasters are finding very little encouragement, trade remaining exceedingly dull. A few orders for best bars are still being received, but the continuation of the engineering dispute is making things worse as each day passes. Ironmasters complain of the unremunerative price obtainable for their products, and some firms report actual losses per ton of iron produced, ranging from £1 10s. to £4. Fortunately, makers of common bars are this week better employed with orders from makers of nuts and bolts. The long-continued depression in the nut and bolt industry is lifting, slowly, it is true, but it is none the less welcome on that account. Manufacturers have got more orders on hand than they have had for some time, and they are in a position to buy their bar iron at a cheaper rate than at any period since 1915. The quotation for this class of iron to-day stands at £10 5s., and it is said that concessions even on this figure are made to obtain orders. Crown bars are being sold locally at £11 per ton. For fencing iron £10 7s. 6d. to £10 10s. is asked. Hardly any foreign iron is reaching the district, although the cheaper qualities are still appreciably below the home prices. Belgian firms are offering nut and bolt quality iron at £9 6s. delivered Darlaston. Makers of sheets find a rather better call for their products, restricted mainly, however, to special and higher qualities. Light tinned sheets used for motor work are also in improved demand. Makers of galvanised sheets have recently been showing a tendency to quote higher prices, but they are having great difficulty in securing any advance. A week ago some firms were quoting £16 10s., but inquiries suggest that this figure is above the ideas of prospective buyers, and £16 5s. may be taken as about the market level. A fair amount of inquiry is experienced for black sheets.

### Steel.

The steel trade continues to show improvement in various directions. Inquiries, though small, are increasingly numerous, the aggregate tonnage keeping certain large firms fairly occupied. Prices remain comparatively firm. Some billet makers are increasing their quotations by 2s. 6d. per ton to £7 17s. 6d., and a few local firms continue to quote £8. But these prices are said to be beyond the ideas of buyers. Indeed, certain merchants claim to be able to buy good tonnages at £7 12s. 6d. The ruling quotation remains at £7 15s. High-carbon billets, of which Sheffield is the chief consumer, although fair quantities are taken in Birmingham, have been reduced 10s. per ton, making the price £8 5s., according to quality. Foreign competition is not serious just now, but one or two Belgian quotations have been received this week for finished steel, joists, for example, being offered at £7 8s. Antwerp, and angles at £8. When the additional cost to Birmingham is added, this material would undersell the English steel. The quoted figure for plates is not attractive, owing to the higher cost of transport of this material. Belgians are forecasting higher prices for the future, by reason of the expected appreciation of the franc. Re-rolled steel continues firm, in sympathy with the relative high cost of billets.

### Foundry Trades Exhibition and Conference.

A Foundry Trades Exhibition, the first of its kind ever held in Europe, is to be opened at Bingley Hall, Birmingham, next month. It has been organised by the Institution of British Foundrymen and the Birmingham Chamber of Commerce, and is to synchronise with the annual Conference of the Institution, whose members will gather in Birmingham from all parts of the country to discuss an important programme of foundry papers. Although this Institution was founded in Birmingham in 1903, this is only its second visit to the district. It has now over 2000 members, and the influence it holds in the industrial world has enabled it recently to obtain its Royal Charter. Besides the technical sessions, various social functions and visits to representative works have been arranged.

### Cannock Chase Miners' Wages Reduced.

The wages for Cannock Chase miners for the month of May, as fixed by the Wages Board for the Eastern Area, show varying reductions, ranging from 2d. per day for boys to 8d. per day for stallmen, the percentage for May being 79.71 upon a 1911 basis, this being a reduction of 10.66 compared with April.

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## LANCASHIRE.

*(From our own Correspondents.)*

MANCHESTER, Thursday.

### Iron and Steel

THE attention of the iron and metal markets in Manchester is now directed to the efforts which the Government is making to bring about a settlement in the engineering industry, and meanwhile very little new business is being done. The advantages of a fairly amicable settlement, such as that which has just been reached in the cotton trade, are obvious to everyone; and hence some people think that it was unwise of the employers to choose this time for inducing the men to come back singly or in small groups—of course, under an undertaking to observe the masters' terms. If the struggle should peter out in this way, there will certainly be a very sore feeling left behind, and we may expect it to lead to mischief. There is no doubt that the men are anxious to get back to work, and this anxiety ought to facilitate the efforts of the Government.

### Metals.

The demand here for the non-ferrous metals is much the same as it was last week. There are only a few buyers willing to act, and as there is no immediate apprehension of higher prices, those whose work is at a standstill naturally keep out of the market. If there were any firm belief in a prompt advance in copper prices, no doubt a good deal of forward buying might take place, for stocks of copper, tin, &c., in consumers' works are certainly low; but while there is no such belief, most consumers prefer to wait until they are ready to use metal, and to take the chance of the market then. The selling prices for refined copper have not been altered for some time, and the small fluctuations in standard copper are ignored. The Indian demand for manufactured sheet copper has become rather worse of late, and the offer of Indian "brazier" sheets at considerably less than the home price for strong sheet copper does not seem to stimulate buying for that market. The large difference between refined copper and manufactured copper is, of course, a very great puzzle to the Indian native buyers. The general opinion in the market seems to be in favour of rather steady prices for some time, and this view may be right; but it is as well to remember that copper prices are low, and that schemes for electrification are coming forward. There is the Luxembourg Government tender to be considered, for this will mean quite a considerable demand for copper, and there are also French schemes for the electrification of railways. The very low prices accepted for old metals, such as gun-metal and yellow brass, tend to check the demand for copper for mixing purposes. With good gun-metal offered freely by dealers at £45 per ton, it is asking too much to expect the user to make it by mixing copper at £64 and tin at £155 per ton. One would have to put in a lot of spelter or lead to bring the mixture within £20 of the price at which it can be bought in the form of old bearings. Old yellow brass is equally cheap, and, in fact, the dealers are not giving much more for old brass than for old lead. The market for tin seems to be a little more settled this week. The outlook is not quite clear, because it is not known whether or not the Eastern holders will sacrifice more of the dear metal held in reserve. Perhaps they are now abandoning the idea that it will pay to hold this tin for over £200 per ton. The demand for tin from the South Wales tin-plate works is expected to be fairly good during the next month or two. Lead has again been a strong market, but the arrivals of lead have been large lately, and there are indications that the Spanish strikes are coming to an end. Spelter has been a quiet, but steady market, and there are still no offers here of German metal, and very little offering from Belgium.

### Foundry Iron.

The market for foundry iron here is further depressed by the fear that the lock-out in the engineering trade will now be extended to the ironfoundries. There are still a few foundries in this neighbourhood which have some work in hand, although this does not amount to much. The output of foundry iron, however, is small, and up to recently the Midland furnaces have been kept fairly clear of accumulations; but now it seems probable that some accumulation of foundry iron at the furnaces must take place, and the question will then arise whether some of these furnaces must be blown out. In the present uncertain state of the consuming markets, it is a little risky to allow unsold pig iron to gather at the furnaces, especially as there is a distinct tendency towards a fall in coke; and if this takes place, the furnaces now idle might start so soon as the labour troubles were settled, and make pig iron at less cost. The prices usually quoted this week for delivery in Manchester range from 90s. to 95s. per ton for Midland No. 3 iron; but very few, if any, buyers are to be found. At a considerably lower figure, it might be possible to induce foundry owners to buy pig iron for stock. The position in Cleveland is better than it is in the Midland district, because the export demand for No. 3 is almost equal to the task of absorbing all the iron now being made in that district, so that at present there is no danger of awkward accumulations.

### Finished Material

This week there is little inclination to buy manufactured iron and steel; but so far the home prices have not been altered. A better export inquiry is reported, but, of course, at unremunerative prices. There are Eastern buyers of finished iron and steel in the market, but their orders will probably be supplied from Belgian ports.

### Scrap.

The trade in scrap iron and steel is practically suspended here for the time. The dealers quote £3 delivered for heavy wrought, 45s. on trucks for melting steel scrap, and from 80s. to 90s., according to quality, for foundry scrap delivered.

### The Spearing Boiler.

On Friday last, in company with the directors of the Spearing Boiler Company, Limited, I had an opportunity of inspecting the works of that company at Hyde, near Manchester. These works were until recently owned by Tinkers, Limited, but have now been acquired by the Spearing Boiler Company, and are being adapted to the construction of water-tube boilers. The premises are situated near Newton Station, on the Great Central Railway, and contain machinery, most of which can be directly utilised for the manufacture of water-tube boilers. The capacity of the works at the present time is said to be three boilers per week, but it is the intention of the owners to carry out considerable extensions on land adjoining the present works, so that the output can be considerably increased. With this object, the company has ordered from John Musgrave and Sons, Limited, a large set of electrically driven plate-bending rolls, capable of bending plates up to 20ft. in length and 1¼in. thick. A feature of this apparatus will be a hinged bearing to allow the cylinder being easily withdrawn from the top roller. The bottom rolls are driven by a 75 brake horse-power electric motor through steel gearing, and the motor is provided with a solenoid brake for quick stopping. For the adjustment of the top roller a 20 brake horse-power electric mofor is used, and each end of the roll is separately adjustable by means of clutches, so that conical plates may be rolled if required. A special feature of the Spearing boiler is the headers, which are of square section, solid drawn from mild steel and fitted with internal caps. The holes over which the caps are placed are oval, so as to facilitate the removal of the cap. When the extensions of the works are completed, it is the intention of the company to make these headers complete in its works.

### Rating of Machinery.

Having passed its second reading in the House of Commons, it may now be anticipated that the Rating of Machinery Bill will speedily become incorporated in the laws of the country. It has long been felt in this great manufacturing centre that movable machinery and tools should not be included in estimating the rateable value of factories for the purposes of local rates. One of the greatest burdens which British industry has to bear at present is that of rates, which in all large producing centres have risen by leaps and bounds. Although there are places with a higher rate than 10s. in the pound—which is the present rate in Manchester on a recently adjusted assessment—Manchester manufacturers feel that under the present adverse conditions of trade the rating is excessive. Cases have come to my knowledge of increases since the war which are difficult to justify. Unlike income tax, rates have to be paid whatever the income of the individual may be—even where there is none—and it seems neither fair nor to the benefit of the community that the producing section should be penalised as it is now by having its plant rated on the present basis. It is both a handicap on British industry, and discouraging to the introduction of new and improved appliances. It is not too much to assert that were it not for the burden of the

local rates, many of the factories employing thousands of hands in this district alone would now be in operation instead of being closed down. The instance mentioned in the House of Commons of the cotton mill at Wigan in which the valuation for rating had been quadrupled recently, owing to the inclusion for the first time of weaving machinery, is only one of numbers of such cases that are now crippling the trade of Lancashire.

**Institution of Mechanical Engineers, North-Western Branch.**

A meeting of graduates and others interested in the formation of a Graduates' Section in the North-Western area was held on Tuesday, April 25th, in the engineering lecture theatre at Owens College, Manchester. Professor A. H. Gibson, D.Sc., occupied the chair, and Dr. Hele-Shaw, President of the Institution, addressed the audience on the constitution and the aims of the Institution. He also mentioned some of the projects which the Council was considering, and sought to point out what the aims and objects of a graduates' section should be. The gathering numbered about ninety. At the conclusion of the address, Mr. Lyon (Graduate) proposed and Mr. Lewis (Graduate) seconded, that a section of graduates be formed in the North-Western area. This was carried unanimously. It was then decided that a temporary committee be formed to carry out the arrangements necessary for the formation of a branch. The committee proposed consisted of Messrs. I. Hey, H. Irwin, E. H. Lewis, H. F. Coucher, F. W. Woodfield, and G. Lyon, all graduates in this neighbourhood

BARROW-IN-FURNESS, Thursday.

**Pig Iron.**

The prolonged labour difficulties have their effect upon the hematite iron trade, and there is not the same demand for mixed Bessemer numbers. As soon as a settlement does come, then we can look for improvement and expansion in trade. Owing to the demand not being so heavy, more is going into stock, but it is taking no harm, for when the demand improves there is every reason to expect a rise in price. Pig iron to-day is cheap comparatively speaking. Small cargoes continue to leave West Coast ports for destinations at home and on the Continent, but the orders dealt with are not great. Small orders are still being placed for immediate requirements.

**Iron Ore.**

The iron ore trade is dull, and is suffering from the same trouble as pig iron. Certain amounts are being bought up, but the demand is not heavy, nor likely to be until strike and lock-out clouds have cleared. More foreign ore has come in during the week, and there are several vessels in from Spain on Barrow and Cumberland account.

**Steel.**

The steel trade is very quiet, and there is not much hope of immediate improvement for awhile. A demand for rails on home account is anticipated, but not for many months yet. At present there is little being done, and the orders held are small. The hoop works continue to be active, and it will not be long before the extensions to these successful works will be started. The new departments will deal with a special line of steel section manufacture. Engineering is dull, and is mostly in the hands of apprentices. The iron and steel works have come to terms with their fitters, who went into work again this week. The sliding scale brought their wages below the district rate, and so the local officials brought them out. The new arrangement is that when the sliding scale brings them below the district rate, employers will make it up and deduct the amounts when the scale goes up above the local rate. It seems a pity that the arrangement could not have been made without the men coming out.

## SHEFFIELD.

*(From our own Correspondent.)*

**Labour Now the Barrier.**

Now that Budget hopes and expectations have been set at rest, if not exactly satisfied, Sheffield steel manufacturers and engineering firms are preparing for the revival which is generally regarded as within sight of realisation. The only serious obstacle now remaining is disaffection in the labour ranks. So far as the Sheffield engineers are concerned, they show no signs of a more reasonable attitude, and indeed the invitation extended on behalf of the employers to individual men to return on Wednesday seems to have stiffened the men, and an elaborate plan of "mass picketing" was devised with the object of not only countering this attempt on the part of the employers, but of preventing those men who have been working through the dispute from reaching the works on Wednesday morning.

**More Furnaces Starting.**

While there is certainly not an overwhelming accumulation of orders, there is undoubtedly sufficient to warrant a re-start on a fairly general scale, and every day, almost, brings a slightly more satisfactory outlook in this respect. More furnaces have been started this week, both in Sheffield and in the Lincolnshire ironstone district, from which Sheffield receives a good deal of its supplies. From the Middlesbrough and Barrow furnaces increased supplies have been coming in for the past week or two, and it is only reasonable to suppose that, despite their denials of any appreciable improvement, Sheffield steel makers are not replenishing their stocks of raw and semi-manufactured material without sound reason. Here and there, it is true, one finds pronounced pessimism. Mr. A. G. Longden, presiding at an extraordinary general meeting of the shareholders of Bessemers, Limited, the other day, for instance, said that he could see no hope of a dividend on the present year's working. He failed to observe any signs of an improvement in the steel trade in the present year. This, however, is by no means a generally shared view. A further step towards stabilisation of prices will be reached next week, as the result of another revision of the sliding scale wages agreement in the steel ingot industry, which shows a reduction of 13¾ per cent.

**Securing for Orders.**

Numbers of local manufacturers also find some grounds for encouragement in the proceedings at the Genoa Conference. Quite apart from political questions, it is recognised that with a country of the enormous undeveloped resources and potentialities of Russia lying moribund, a great field for the steel and engineering industry remains unexploited. The agreement with Germany may not, on the face of it, seem to help matters so far as this country is concerned, but Sheffield manufacturers take the view that once the work of reconstruction gets started, there will be opportunities for British as well as German enterprise. Indeed, certain of the more enterprising and far-seeing Sheffield firms are confident that a considerable volume of business awaits them in even more distant countries, and arrangements are being made for round-the-world trips by one or two directors of Sheffield concerns. Meantime, Metropolitan-Vickers are beginning to get busy on the execution of the million-pound South African railways electrification contracts which they secured a few months ago. The electrical departments in Sheffield generally have plenty of orders to last for many months to come, as soon as the labour situation settles. Makers of railway material are also preparing for the orders which it is felt cannot be much longer delayed, both on home and foreign account. There has been a small revival during the past few days in overseas orders for crucible steel, files and edge tools, and it is clear that not only the Colonies, but South America, are coming into the market again. On the other hand, the spell of activity which a few local firms have enjoyed in the supply of shovels, spades and other gardening and agricultural implements is relaxing somewhat, but there is a steady demand for saws, especially of the recently perfected fitted-tooth circular type for metal as well as timber work. Stainless steel is still a popular line, and is finding new uses practically every week. The latest application is in the making of spades and shovels, which, though necessarily considerably more costly than the ordinary kind, present such outstanding advantages that a certain demand is fairly sure to follow. There has been a marked falling off in the demand for motor car parts, many of which, including forged shafts for some of the most famous cars on the market, have been made in Sheffield.

**A Legislative Handicap.**

Reference to forgings reminds me that the rolling mills and forges will be severely handicapped in the recruiting of their skilled labour as a result of the operation of the Women, Young Persons and Children Employment Act of 1920, which enacts that no young person between the age of fourteen and sixteen must on any account work between the hours of 10 p.m. and 5 a.m., and young persons between the age of sixteen and eighteen can only be so employed providing the process is a "continuous" one, and that the permission of the Inspector of Factories is obtained. The result is that on July 1st, when this Act comes into operation, all boys and youths under the age of sixteen will have to be discharged from the rolling mills and forges. Hitherto, these works have obtained their employees largely from the boys on leaving school at fourteen. The industry is, of course, a "continuous" one, and the employees work in "sets," and it will be found difficult to rearrange those sets so that the boys in it shall work only during the day and be replaced by older and skilled men during the night. A boy or youth learning the trade must almost of necessity work on the various shifts in rotation, both for the sake of his own efficient instruction as well as for the successful carrying out of the work. The new Act is the outcome of an International Labour Conference held at Washington in 1919, when the abolition of all night work for young people was recommended. Of the fifty-three countries represented, Great Britain is the only one that has carried out this recommendation. The consequences are so seriously regarded that a meeting representative of the leading firms in the industry in Sheffield has passed a resolution viewing the prospect with alarm, and urging the steel manufacturing and other organisations to use every means in their power to bring pressure to bear on the Home Secretary to receive a deputation in order that the seriousness of the matter may be brought to the notice of the Government.

**The Fuel Position.**

There has been no marked change in the coal position during the past week. Many of the collieries have large stocks, especially of small coal and inferior kinds of slack, for which almost any price will be considered. The restarting of additional furnaces and plant has quickened the demand for industrial coal and blast-furnace coke to some extent, but not to a degree that has affected quotations. The export business has been a little easier, buyers evidently waiting to see if the wage basis for the month will show any change in their favour. For this area it has now been fixed, and shows a drop of about 10 per cent. on the base rates. This will doubtless be reflected in subsequent quotations.

## NORTH OF ENGLAND.

*(From our own Correspondent.)*

**Germany as Cleveland's Best Customer.**

THE most interesting feature of the present situation in the Cleveland pig iron industry is the fact that Germany has once more assumed the position of being Cleveland's heaviest foreign buyer for pig iron—a distinction which that country held for many years prior to the war. During April alone, Germany received more pig iron from Cleveland than the total foreign exports of pig iron from the district in any month of last year. Some of this iron has gone to the very heart of the German steel industry—Essen, the home of Krupps. Not only Germany, but also Austria and Hungary are now taking pig iron supplies from Cleveland, and although France, Belgium and Italy have not taken such large quantities as in the previous month, the result is that Cleveland's foreign trade in pig iron for April is represented by a total of 27,603 tons. Adding the coastwise shipments, which included very heavy despatches of East Coast hematite to South Wales, the aggregate exports from Cleveland for the month totalled 44,183 tons, a figure which has not been exceeded since July, 1920. Germany received 11,532 tons, Belgium 4501 tons, Italy 3045 tons, France 2235 tons, Japan 1600 tons, and Sweden 1136 tons. The development in the foreign trade is particularly appropriate at the present time, when industrial troubles at home have reduced the home requirements to a very low scale. There is no doubt that but for the demand for pig iron abroad some of the furnaces would have been put out of operation ere now.

**Finished Iron and Steel Exports.**

The position so far as the export trade in manufactured iron and steel is concerned is not so encouraging. The returns for April show a marked decline. The disturbed conditions in the Far East have exercised a noticeable effect, and the shipments of manufactured iron and steel to India and Ceylon were over 11,000 tons less than in the previous month. To Japan the exports fell from 3659 to 424 tons, and there was also a falling off in the shipments to China. The Argentine Republic, to which about 11,500 tons of steel have been shipped from Cleveland this year, only received 3 tons in April. This latter is, however, only a temporary relapse, and in the shipment of 2085 tons to Peru there is evidence of the further development of an important connection with the South American Republics. Substantial business has also been done with the Gold Coast, and it is understood that further cargoes of railway material are destined for the West Coast of Africa. The exports of manufactured iron and steel for April totalled 42,719 tons, as compared with 58,746 tons in March.

**Iron and Steel Imports.**

Statistics presented at a meeting of the Tees Conservancy Commissioners on Monday showed that for the six months ending April 30th, the imports of pig iron to the Tees ports from Holland, Belgium, France, Germany, Norway and Sweden and coastwise reached 30,160 tons, as compared with 14,134 tons for the previous half year, and only 106 tons in the six months pre-war period in April, 1914. The imports of billets, slabs, blooms, &c., from the countries named amounted to 27,822 tons during the past six months, as against 16,013 tons in the previous six months and 24,134 tons for the half year ending April, 1914. Plates, bars, angles and rails imported during the half year just closed totalled 2869 tons, as compared with 12,834 tons for the previous six months and 13,460 tons for the corresponding period up to April, 1914.

**Cleveland Iron Market.**

Although a firm tone is maintained on the Cleveland pig iron market, business continues to slacken. The fact is that the engineers' lock-out is gradually strangling trade. Many of the engineering works are wholly or partially idle, and the home demand for pig iron has been narrowed down to extremely small proportions. Moreover, the foreign inquiry has been much less active this week. The Scottish demand for Cleveland pig iron has fallen off in a most marked degree, and even the offer of No. 3 G.M.B. at the fixed price of 96s. 8d. f.o.t. Grangemouth fails to attract buyers. To other destinations the following uniform prices are quoted:—No. 1 and siliceous iron, 95s.; No. 3, 90s.; No. 4 foundry, 87s. 6d.; No. 4 forge, 85s.; and mottled and white, 83s. per ton.

**Hematite Pig Iron.**

The position in the East Coast hematite pig iron trade has become much easier. South Wales is still taking large quantities, but the output is not now so fully absorbed, and prices are inclined to sag. Sales of mixed numbers are reported as low as 95s. to 95s. 6d. for export, but not less than 96s. is asked for home consumption, and some makers refuse to take less than 97s. per ton, No. 1 in all cases being quoted at 1s. per ton premium.

**Iron-making Materials.**

There is scarcely any business passing in the foreign ore trade, and although many sellers maintain recent prices, it is believed that 27s. per ton c.i.f. might possibly be shaded for best Rubio. Coke prices are just a shade easier, and good Durham qualities can be bought at 28s. per ton delivered at the works.

**Manufactured Iron and Steel.**

There are no signs of any expansion of business in manufactured iron and steel, and the general position is very discouraging. A revival is badly needed, for works are operating from hand to mouth, and are often laid completely idle. Prices, however, are maintained.

**The Coal Trade.**

The general position in the Northern coal trade has not undergone much material change. The outlook, however, appears to be more satisfactory, and many of the collieries are heavily booked up to the beginning of June. The inquiries appear to be fuller, and as some of the supplies which were freely offering have been cleared, there is not the same opportunity for bargaining. The British Admiralty is still in active negotiation for steam coals, and it is understood that it has made some small purchases of Tyne primes at fairly cheap rates, although the actual price paid has not been disclosed. The Danish State Railways' contract for 100,000 tons of best steams for shipment up to the end of this year has been put back, and tenders are now returnable up

to May 9th. Steam coals are steady for all Blyth sorts, but in the case of Tyne primes, there are quantities of screened sorts offered rather cheaply. Second steams are in need of trade, and can be secured advantageously for a prompt turn. Best steam smalls are steady at full figures. The Durham market continues to be uncertain. Best Durham steams are firm and scarce, and prime gas sorts are at full values and fully stemmed for some time ahead, but in almost every other direction the market is patchy and erratic. Second gas coals are generally easier, though some brands are steadier than others. Bunker coals are slow, and though bests and superiors are maintained, ordinaries are freely offered at minimum figures. The coke market is unchanged, and is steady for all classes.

## SCOTLAND.

*(From our own Correspondent.)*

### Shipbuilding: Lowest Output.

THE combination of labour troubles is responsible for bringing about a situation practically without precedent in the Scottish shipbuilding industry. From the Clyde area during the past month only one vessel of 25 tons was launched. Work at the yards is practically at a standstill, and though the outlook is perhaps a trifle brighter, a considerable time must elapse before anything in the nature of a recovery can take place. At the various yards a fair amount of work remains to be completed, but there is an absence of inquiry for new tonnage. Any immediate change in the outlook therefore takes the form of hope for a speedy settlement of trade disputes on a basis likely to induce owners to consider new tonnage. During April only three launches were recorded for the whole of Scotland. The returns for this year to date amount to thirty-two vessels of 106,087 tons, compared with eighty-three vessels of 172,677 tons in the same period in 1921

### Stoppage at Fireclay Works.

Great depression has been caused in the Castlecary district of Stirlingshire by the announcement of a stoppage of work at Messrs. J. G. Stein and Co.'s fireclay works. These works, said to be the largest in Britain, have been kept going through the period of bad trade, but large stocks have accumulated. A stoppage therefore is necessary for a period of from two to three months. Several villages in the area are wholly dependent upon the fire-clay industry.

### Pig Iron.

There has been no change in the position of Scotch pig iron. The demand has not increased, and stocks continue to accumulate. Prices are not altered to any extent, but producers are willing to make every possible concession. The usual weekly meeting of the Glasgow pig iron ring again passed without any business being done. Last week sellers of makers' iron quoted as follows:—Scotch No. 3, 97s. 6d. cash, f.a.s. Glasgow; Middlesbrough No. 3, 97s. 6d. cash, f.o.b. Middlesbrough; mixed numbers East Coast hematite, 97s. 6d. cash, f.o.b. Middlesbrough. Scotch No. 3 warrant iron at 98s. 6d. one month, seller, was also quoted.

### Steel and Iron.

Steel makers have curtailed working shifts in order to keep their establishments open, but in spite of all efforts, great difficulty is experienced in maintaining even a semblance of activity. Orders for plates and sectional material are very scarce. Practically nothing is passing on home account, and though makers are open to cut prices for export business, their efforts meet with little success. Steel sheets have dropped off, the activity of a month or so ago not being continued. Foreign inquiries have come to hand, but in order to secure firm orders makers have to name a price which leaves a very small, if any, margin of profit. Malleable bar iron makers have gained nothing from their last reduction of 10s. per ton, and orders are as fugitive as ever. Crown quality bars remain nominally at £11 per ton home and £10 15s. export delivery, but something less could be done for a good specification. Iron and steel castings, tubes and other departments are likewise very much in need of fresh business.

### Coal.

Conditions in the coal trade are discouraging. Prices are falling, but the consumption is not increasing, and markets are dull. The industrial situation restricts home sales, and any business passing is purely from hand to mouth. The export department, too, is having a lean time. Shipments are almost wholly coastwise, foreign orders being conspicuous by their absence. Outputs have been fair, and colliery sidings are becoming congested with loaded wagons, despite a curtailment of the working week. The drop in export business is most severely felt in the Lothians and Fifeshire, and especially in the latter is there a considerable amount of distress amongst the miners. Fuel is now at a fairly reasonable price, but there is a lack of buyers, markets abroad being evidently well stocked at present. It is said that in Fifeshire in the meantime £3 per week constitutes an average weekly earning. Aggregate shipments for the past week amounted to 214,173 tons, against 243,720 tons in the preceding week and 316,080 tons in the same week in 1913. Prices are nominally only a shade easier, but in practically all descriptions of fuel cheaper prices can be arranged. Single nuts and pearls are perhaps the only exceptions.

### Miners' Wages.

At an executive meeting of the National Union of Scottish Mine Workers, the ascertainment for March was submitted, and showed a reduction of 3 per cent. on workmen's wages for the month of May.

## WALES AND ADJOINING COUNTIES.

*(From our own Correspondent.)*

### Coal Trade Outlook.

THE position regarding the steam coal trade can scarcely be said to be as sound as it was a week ago. The fact is that the continued absence of the steady flow of inquiry that is evident in normal times is beginning slightly to tell its tale, notwithstanding that collieries have sold a fair amount of coals for forward shipment. The quantity that has been disposed of is evidently not sufficient to keep the market at its present level and firm at that. For some time past it has been noticeable that consumers abroad have only been buying on the hand-to-mouth principle for the reason that they considered that it was in their interest to do so in the belief that the present high prices would not be maintained. The demand at the moment is mainly for the best qualities, and there is no doubt that lower grades are not so steady as was the case recently, although they have not as yet given way materially in price, but it looks very much as if they will have to come down if they are to get business. This is emphasised by the way in which South Wales is cut out of the orders for Scandinavia. Collieries in the North are quoting much lower prices than owners in this district, with the result that buyers cannot ignore this difference, especially when it is coupled with lower rates of freight. The latest news shows that with regard to the recent inquiry by the Norwegian State Railways for 45,000 tons of best Admiralty large double-screened for delivery over this month and next, not a ton of the order came to this district. South Wales prices were round about 30s. per ton, but the business went to Lambton and South Hetton coals principally, at prices ranging from about 26s. to 26s. 6d. On this basis it does not look as if South Wales will stand much chance in competing for the Danish State Railways' inquiry of 75,000 tons for delivery from June to August inclusive, for which tenders have to be in by the 9th inst.

### Miners' Wages.

Improved prices for coals have not so far affected the miners' wages, although hopes are entertained that this will be the case next month. The certificate of the joint accountants, giving the proceeds and costs in this district for March last, shows that after allowing for the cost of standard wages, other costs and the owners' standard profits of 17 per cent., the percentage on the 1915 standard rates which the industry can afford to pay for May is 16.76. After meeting the cost of standard wages, other costs and providing for the owners' standard profits, the surplus available is £227,837, and under the terms of the National agreement, this is divisible in the proportions of 83 per cent. to the workmen and 17 per cent. to the owners. The first charge upon the industry, however, is a minimum wage of 28 per cent. on the 1915 standard base rates. The proceeds in March are not sufficient to enable the owners to pay that minimum without the sacrifice, not only of their share of the surplus, but £171,371 of their standard profits for that month. In the five months ending March, the loss under the agreement to the owners when calculated on a district basis has amounted to about £1,309,000. This huge figure represents the profits actually surrendered by the owners to pay the minimum wage rate. But this is not the only sacrifice. There is the indirect loss of the surplus profits which would have accrued to the owners if the industry had been on an economic basis. If this had been the case, the industry would have earned a revenue which would have given a surplus sufficient, not only to pay the minimum wage, but also to allow the owners their share of such surplus. But as pointed out, the surplus has not been sufficient to pay the minimum wage, and when the sacrifices made by the owners in the surrender of their standard profits and surplus profits are taken into account, the total amount sacrificed by the owners during the five months ending March 31st is no less than £1,674,065.

### May Day Outpourings.

Monday last was a holiday in the coalfield, and also "demonstration" day for the miners, and they availed themselves of it to hold mass meetings in the various districts, at which their grievances were thoroughly ventilated, and advice to the miners, threats to the owners, railery at the Government, &c., were freely poured out. Consolidation of their ranks was urged by the saner of the leaders, while the extremist advocated the establishment of the "glorious Soviet" as the solution of all the ills from which the miners are suffering. The President of the South Wales Miners' Federation said that the Welsh miners had for some time been retreating at the double before the coalowners. The time had come when they should turn and "dig in," and consolidate their position so that they might make an early advance to recover the positions they had lost. He said that on Monday next, when the coalfield conference is to be held, the men would be asked whether they had the grit and stamina to stand up for themselves once again, or whether they would continue to allow the coalowners to treat them as they had been treated during the last nine months. If the Executive got the assurance from the conference that there was a disposition in the coalfield to resent that treatment, they would find a body of leaders who were prepared to marshal the revolt and lead it.

### Notices to Miners.

The Ebbw Vale district, which has suffered much misfortune of late months, is to experience further trouble in the way of unemployment, as notices have been issued to the men employed at the No. 2 Waunllwyd Colliery to terminate their contracts with the Ebbw Vale Company, and just over a thousand miners are affected. The reason given for this action is that the colliery is not remunerative. A good deal of the trouble at the Ebbw Vale collieries is due to the fact that there is no new definite price list upon which the company can work the collieries. This trouble goes back as far as last August, when the men resumed work after the stoppage throughout the coalfield. The company only agreed to reopen the collieries on the distinct understanding that a new price list should be arranged as quickly as possible. The matter was arbitrated upon and the arbitrator gave an interim award, referring the position back to the districts, but nothing definite has since been done, though the company contends that it has endeavoured to get an understanding.

### Current Business.

The steam coal market displays very little activity so far as new business is concerned, but the tone of the best large and small coal qualities remains fairly good. In the case of the lower descriptions, the inquiry is very moderate, and collieries are in need of orders to keep them in anything like a satisfactory position. Patent fuel makers are in all the circumstances well placed for early shipment. As regards the anthracite section, large coals are firmer, but some of the sized coals are rather irregular. Owners, however, will only sell for prompt shipment. They decline to quote for delivery ahead in the strong belief that the continuation of the strike of the American miners will mean much higher prices for their coals for later delivery.

# Latest News from the Provinces.

## THE MIDLANDS AND STAFFORDSHIRE.

### The Engineering Lock-out.

FAILING a decision by the Engineering Employers' Federation to suspend the lock-out while the inquiry is in progress, the notices to the members of the unions other than the A.E.U. took effect on Wednesday in the Midlands, in common with other parts of the country. The employers have thrown open their shops to a certain number of workers who accept the three conditions relating to managerial control of which the employers have given notice. Information, so far as it is available at the time of writing, from the large works in Coventry, Birmingham and Wolverhampton appears to show a lack of cohesion and unity on the part of the workers. A considerable number of skilled men in the allied unions have undoubtedly entered most of the factories, most of which are proceeding normally. Some firms report that the lock-out has not had the slightest effect in reducing the numbers at work, and while others admit some defections, they state they are on the whole satisfied with the response to the notice inviting the workpeople to continue. It is reported in some cases that A.E.U. members have gone in. There have been some ugly incidents at Coventry, but many engineers continue to avail themselves of the work provided. At Wolverhampton most of the leading firms are in a local employers' organisation, and are not affected by the lock-out. Inquiries at the federated shops show that most of the men in the allied unions are working as usual.

## LANCASHIRE.

### The Lock-out.

The decision of the employers in the Federation to open their works to members of the Amalgamated Engineering Union on Wednesday met with practically no response in the Manchester district, and the number of men out of employment has been greatly increased by the extension of the lock-out to the other trade unions. Although no case of serious disturbance has come to my knowledge, the pickets are becoming much more active, and are preventing many men who are not in the unions from going into the works. Several works have closed down altogether.

## SHEFFIELD.

### The Extended Lock-out.

The extension of the lock-out in this district was the signal for an increase in the activities of the pickets, and, working in bodies about 400 strong, they visited various works where men were still working; but, generally speaking, without success in their persuasions to bring these men out. Strong forces of mounted police, supplemented by further contingents sent in motor coaches, protected the works, and no damage was done, although the attitude of the pickets was threatening. Most of the works are still running with sufficient men—apart from those locked out—to deal with the orders in hand, and there is no indication of a total stoppage.

## WALES AND ADJOINING COUNTIES.

### Notices Withdrawn.

The Ebbw Vale Company has withdrawn the notices served on Saturday last upon 1000 colliers engaged at the No. 2 pit, Waunllwyd. The owners of the Nos. 1 and 2 pits, Bedlinog, have tendered fourteen days' notice to the men employed on the ground that the pits have proved unremunerative.

### Fire Damage.

About 300 men are rendered idle owing to an outbreak of fire on Tuesday at the works at Landore belonging to Messrs. Baldwins, Limited. The building in which the fire broke out had lately been used as an engineering shop, and was the maintenance shop for all Baldwin's works in South Wales. Valuable machinery and a large number of patterns were destroyed.

LANTERN SLIDES.—Bellias and Morcom, Limited, Ledsam-street Works, Birmingham, inform us that they have the following sets of lantern slides, each consisting of twenty slides with a booklet of descriptive matter, which they will be pleased to supply on loan for lecture purposes:—(1) Quick-revolution engines with forced lubrication, and (2) the production of power at low cost in conjunction with heating and drying by exhaust steam.

# Current Prices for Metals and Fuels.

## IRON ORE.

| | |
|---|---|
| **N.W. COAST—** | |
| Native | 28/- |
| (1) Spanish | 28/- |
| (1) N. African | 28/- |
| **N.E. COAST—** | |
| Native | — |
| Foreign (c.i.f.) | 27/- |

## PIG IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| (2) **SCOTLAND—** | | |
| Hematite | 5 5 0 | — |
| No. 1 Foundry | 4 17 6 | — |
| No. 3 ,, | 4 12 6 | — |
| **N.E. COAST—** | | |
| Hematite Mixed Nos. | 4 16 0 | 4 15 0 to 4 15 6 |
| No. 1 | 4 17 0 | 4 16 0 to 4 16 6 |
| Cleveland— | | |
| No. 1 | 4 15 0 | 4 15 0 |
| Silicious Iron | 4 15 0 | 4 15 0 |
| No. 3 G.M.B. | 4 10 0 | 4 10 0 |
| No. 4 Foundry | 4 7 6 | 4 7 6 |
| No. 4 Forge | 4 5 0 | 4 5 0 |
| Mottled | 4 0 0 | 4 0 0 |
| White | 4 0 0 | 4 0 0 |
| **MIDLANDS.** | | |
| (3) Staffs.— | | |
| All-mine (Cold Blast) | 13 0 0 | — |
| Part Mine Forge | *None offering.* | |
| North Staffs. No. 3 F'dry | 4 5 0 to 4 10 0 | |
| (3) Northampton— | | |
| Foundry Nos. 2 and 1 | *Nominal.* | |
| ,, No. 3 | 4 0 0 | — |
| ,, Forge | 3 10 0 to 3 12 6 | |
| (3) Derbyshire— | | |
| No. 3 Foundry | 4 2 6 to 4 5 0 | |
| Forge | 3 12 6 to 3 15 0 | |
| (3) Lincolnshire— | | |
| Basic | 4 0 0 to 4 5 0 | |
| Foundry | 4 5 0 to 4 10 0 | |
| Forge | 4 2 6 to 4 5 0 | |
| (4) **N.W. COAST—** | | |
| N. Lancs. and Cumb. | | |
| Hematite Mixed Nos. | 5 15 0 | — |

## MANUFACTURED IRON.

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| **SCOTLAND—** | | |
| Crown Bars | 11 0 0 | 10 15 0 |
| Best ,, | 12 0 0 | — |
| **N.E. COAST—** | | |
| Common Bars | 12 0 0 | — |
| Tees | 14 10 0 | — |
| **LANCS.—** | | |
| Crown Bars | 11 10 0 | — |
| Hoops | 14 0 0 | 13 15 0 |
| **S. YORKS.—** | | |
| Crown Bars | 12 0 0 | — |
| Best ,, | 13 0 0 | — |
| Hoops | 14 0 0 | — |
| **MIDLANDS—** | | |
| Marked Bars (Staffs.) | 13 10 0 | — |
| Crown Bars | 11 10 0 | — |
| Nut and Bolt Bars | 10 5 0 to 10 10 0 | |
| Gas Tube Strip | 11 10 0 to 11 15 0 | |
| Hoops (*Nom.*) | 14 0 0 | — |

## STEEL.

| | (6) Home. £ s. d. | (7) Export. £ s. d. |
|---|---|---|
| (5) **SCOTLAND—** | | |
| Boiler Plates | 14 0 0 | — |
| Ship Plates ⅜in. and up | 10 10 0 | — |
| Sections | 10 0 0 | — |
| Steel Sheets ⅛in. to ⅜in. | 11 15 0 | — |
| Sheets (Gal. Cor. 24 B.G.) | — | 16 10 0 |

## STEEL (*continued*)

| | Home. £ s. d. | Export. £ s. d. |
|---|---|---|
| **N.E. COAST—** | | |
| Ship Plates | 10 10 0 | — |
| Angles | 10 0 0 | — |
| Boiler Plates | 14 10 0 | — |
| Joists | 10 10 0 | — |
| Heavy Rails | 9 10 0 | — |
| Fish-plates | 14 10 0 | — |
| Channels | 14 10 0 | — |
| Hard Billets | 9 5 0 | — |
| Soft Billets | 7 5 0 | — |
| **N.W. COAST—** | | |
| **BARROW—** | | |
| Heavy Rails | 9 10 0 | — |
| Light ,, | 11 0 0 to 13 0 0 | |
| Billets | 9 5 0 | — |
| Ship Plates | 10 10 0 | — |
| Boiler ,, | 14 10 0 | — |
| **MANCHESTER—** | | |
| Bars (Round) | 10 0 0 to 12 0 0 | |
| ,, (others) | 11 0 0 to 12 0 0 | |
| Hoops (Best) | 15 5 0 | 15 0 0 |
| ,, (Soft Steel) | 12 5 0 | 12 0 0 |
| Plates | £10 to 12 | 10 0 0 |
| ,, (Lancs. Boiler) | 16 0 0 | — |
| **SHEFFIELD—** | | |
| Siemens Acid Billets | 10 0 0 to 11 0 0 | |
| Bessemer Billets | 12 10 0 | — |
| Hard Basic | 9 5 0 | — |
| Soft ,, | 7 15 0 | — |
| Hoops | 12 5 0 | — |
| Soft Wire Rods | 11 0 0 | — |
| **MIDLANDS—** | | |
| Small Rolled Bars | 9 5 0 to 9 10 0 | |
| Bessemer Billets | 7 10 0 to 7 12 6 | |
| Hoops | 11 15 0 to 12 0 0 | |
| Gas Tube Strip | 10 5 0 to 10 10 0 | |
| Sheets (24 W.G.) | 11 10 0 to 12 0 0 | |
| Galv. Sheets (f.o.b. L'pool) | 16 0 0 to 16 10 0 | |
| Angles | 10 0 0 | — |
| Joists | 10 10 0 | — |
| Tees | 11 0 0 | — |
| Bridge and Tank Plates | 10 10 0 | — |

## NON-FERROUS METALS.

| | |
|---|---|
| **SWANSEA—** | |
| Tin-plates, I.C., 20 by 14 | 19/6 to 19 9 |
| Block Tin (cash) | 172 5 0 |
| ,, (three months) | 153 15 0 |
| Copper (cash) | 69 2 6 |
| ,, (three months) | 60 15 0 |
| Spanish Lead (cash) | 24 0 0 |
| ,, (three months) | 23 0 0 |
| Spelter (cash) | 27 2 6 |
| ,, (three months) | 27 0 0 |
| **MANCHESTER—** | |
| Copper, Best Selected Ingots | 65 0 0 |
| ,, Electrolytic | 67 0 0 |
| ,, Strong Sheets | 88 0 0 |
| ,, Loco Tubes | 0 1 1½ |
| Brass Loco Tubes | 0 0 11½ |
| ,, Condenser | 0 1 2½ |
| Lead, English | 25 5 0 |
| ,, Foreign | 24 5 0 |

## FERRO ALLOYS,

(*All prices now nominal*).

| | |
|---|---|
| Tungsten Metal Powder | 1/6 per lb. |
| Ferro Tungsten | 1/4 per lb. |

| | Per Ton. | Per Unit |
|---|---|---|
| Ferro Chrome, 4 p.c. to 6 p.c. carbon | £27 | 10/- |
| ,, 6 p.c. to 8 p.c. ,, | £26 10 0 | 9/- |
| ,, 8 p.c. to 10 p.c. ,, | £25 10 0 | 8/- |
| ,, Specially Refined | | |
| Max. 2 p.c. carbon | £70 | 26/- |
| ,, 1 p.c. ,, | £88 | 30/- |
| ,, 0·75 p.c. carbon | £103 | 37/- |
| ,, carbon free | 2/- per lb. | |
| Metallic Chromium | 5/3 per lb. | |
| Ferro Manganese (per ton) | £15 for home. | |
| ,, Silicon, 45 p.c. to 50 p.c. | £13 0 0 scale 5/- per unit | |
| ,, ,, 75 p.c. | £25 10 0 scale 6/- per unit | |
| ,, Vanadium | 20/- per lb. | |
| ,, Molybdenum | 7/- per lb. | |
| ,, Titanium (carbon free) | 1/3 per lb. | |
| Nickel (per ton) | £180 | |
| Cobalt | 14/- per lb. | |
| Aluminium (per ton) | £110 to £120 (British Official). | |

## FUELS.

| | Export. |
|---|---|
| **SCOTLAND.** | |
| **LANARKSHIRE—** | |
| (f.o.b. Glasgow)—Steam | 20 6 |
| ,, ,, Ell | 21 3 |
| ,, ,, Splint | 21 6 to 24/6 |
| ,, ,, Trebles | 20/- |
| ,, ,, Doubles | 18 6 |
| ,, ,, Singles | 17 6 |
| **AYRSHIRE—** | |
| (f.o.b. Ports)—Steam | 20/- |
| ,, ,, Splint | 21 6 |
| ,, ,, Trebles | 20/- |
| **FIFESHIRE—** | |
| (f.o.b. Methil or Burntisland)—Steam | 18/- to 22/- |
| Screened Navigation | 26/6 |
| Trebles | 20/- |
| Doubles | 18 6 |
| Singles | 18/- |
| **LOTHIANS—** | |
| (f.o.b. Leith)—Best Steam | 20/- |
| Secondary Steam | 19 6 |
| Trebles | 19 9 |
| Doubles | 18 6 |
| Singles | 18/- |
| **ENGLAND.** | |
| (8) **N.W. COAST—** | |
| Steams | 35/- |
| Household | 40/- to 55/- |
| Coke | 34/- |
| **NORTHUMBERLAND—** | |
| Best Steams | 22 6 to 24/- |
| Second Steams | 21/6 to 22/- |
| Steam Smalls | 13/- to 15/- |
| Unscreened | 20/6 |
| Household | 25/- to 30/- |
| **DURHAM—** | |
| Best Gas | 23/- |
| Second | 21/- to 22/- |
| Household | 25/- to 30/- |
| Foundry Coke | 32/6 to 35/- |
| **SHEFFIELD—** | **INLAND.** |
| S. Yorks. Best Steam Hards | 22/- to 23/- — |
| Derbyshire Hards | 21/- to 22/- — |
| Seconds | 20/- to 21/- — |
| Cobbles | 20/- to 21/- — |
| Nuts | 18/- to 19/- — |
| Washed Smalls | 11/- to 12/- — |
| Best Hard Slacks | 12/- to 13/- — |
| Seconds ,, | 10/- to 11/- — |
| Soft Nutty ,, | 9/- to 10/- — |
| Pea ,, | 7/- to 8/- — |
| Small ,, | 4/- to 5/- — |
| House, Branch | 37/- to 39/- — |
| ,, Best Silkstone | 33/- to 34/- — |
| Blast Furnace Coke (Inland and Export) | 19/- to 21/- |
| **CARDIFF—** (9) **SOUTH WALES.** | |
| Steam Coals: | |
| Best Smokeless Large | 28/6 to 29/- |
| Second ,, ,, | 28/- to 28/6 |
| Best Dry Large | 26/6 to 27/6 |
| Ordinary Dry Large | 25/- to 25 6 |
| Best Black Vein Large | 27/6 to 28/- |
| Western Valley ,, | 27/- to 27 6 |
| Best Eastern Valley Large | 27/- to 27/6 |
| Ordinary ,, ,, | 24/6 to 25 6 |
| Best Steam Smalls | 19/6 to 20/- |
| Ordinary ,, | 15/- to 19/- |
| Washed Nuts | 25/- to 27/6 |
| No. 3 Rhondda Large | 30/- to 32/6 |
| ,, ,, Smalls | 19/6 to 20/- |
| No. 2 ,, Large | 23/- to 24/- |
| ,, ,, Through | 19/- to 20/- |
| ,, ,, Smalls | 15/- to 16/- |
| Coke (export) | 34/- to 35/- |
| Patent Fuel | 25/- to 28/- |
| Pitwood (ex ship) | 29 6 to 30 6 |
| **SWANSEA—** | |
| Anthracite Coals: | |
| Best Large | 37/6 to 40/- |
| Seconds | 30/- to 35/- |
| Red Vein | 28/- to 31/- |
| Big Vein | 25/- to 37/6 |
| Machine-made Cobbles | 47/6 to 50/- |
| Nuts | 45/- to 50/- |
| Beans | 45/- to 50/- |
| Peas | 24/- to 26/- |
| Breaker Duff | 10/- to 10 6 |
| Rubbly Culm | 16/- to 17/- |
| Steam Coals: | |
| Large | 22 6 to 24 6 |
| Seconds | 20/- to 22 6 |
| Smalls | 14/- to 16/- |
| Cargo Through | 13/- to 20/- |

(1) Delivered. (2) Net Makers' works. (3) At furnaces. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—F.O.B. Glasgow.

(8) Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b.

# French Engineering Notes.

*(From our Correspondent in Paris.)*

### Trade Organisation.

THE instability of the trade situation has again been the subject of discussion this week by the union of the mechanical, electrical, and constructive engineering industries. Now and then business becomes a little more active, but the spurt of confidence dies out as soon as clouds appear on the horizon, and from the French point of view the outlook is by no means reassuring. A week ago there seemed to be elements of a recovery, but they have vanished with the fear that the question of reparations may be called into discussion. The Union is therefore making great efforts to render the industrial position independent of these influences. There are two factors that may give immediate prosperity to the metallurgical and engineering industries, one being the carrying out of the programme of public works and the reconstruction of the devastated areas, and the other the development of a big export trade. As France has everything now to make her the greatest iron and steel producer on the Continent, if only she can procure sufficient supplies of coke, there are possibilities of a heavy surplus production which must be disposed of abroad, and efforts are now being made to realise economies and bring down charges to permit of iron and steel firms exporting material at very low prices. Some time ago French, British and Belgian firms met in Paris to discuss the ways and means of maintaining values, but the negotiations fell through, or were at least suspended, chiefly on account of the opposition of certain Belgian makers who could not agree upon the amount of their participation in foreign contracts. The French now consider that they have a free hand for competing in any way they please. Some rather vague proposals are also being put forward to secure a greater concentration of the metallurgical industry whereby it will be possible to reduce the cost of transporting raw material. So far as the engineering industries are concerned, the Union has appealed to the Government to take immediate measures for putting in hand the various public works, such as the electrification of the railways and the carrying out of colonial undertakings, and it is urged that loans should be raised to permit of structural and other material being delivered to the devastated areas. It is also insisted upon that all this work should be reserved for French manufacturers.

### Railway Rates.

The putting up of railway rates to provide the companies with some compensation for the unsatisfactory results of the eight hours' day and the higher wages has had the effect of still further reducing receipts and increasing the deficit, which is a very serious matter for the companies now that they are no longer able to rely upon the State guarantee. The high traffic charges are regarded as particularly disastrous to industry at a time when it has become absolutely necessary to bring down manufacturing costs. The Superior Council has now authorised the companies to give some satisfaction to manufacturers by according a temporary reduction in the rates on metallurgical products for export. The reduction is to be 40 per cent. on raw and manufactured iron and steel when carried over distances of not less than 400 kiloms., which means that the principal metallurgical centre in the north-east of France will enjoy exceptional facilities for export through Channel, Atlantic and Mediterranean ports. The same concession, in the way of rebate, will be accorded for the carriage of material required for shipbuilding. Reductions of 25 and 35 per cent. will also be made upon the carriage of coal, coke, lignite and other fuels for shipment, in the one case for loads of 20 tons and in the other for loads of not less than 180 tons. These concessions are temporary with a view of seeing whether the lower rates will be accompanied by a corresponding increase in traffic, and if they are not followed by diminished receipts it is probable that the Superior Council will consent to other reductions, especially in the rates for transporting raw material for home consumption.

### Motor Services.

About fourteen years ago the State was authorised to grant subsidies for country services of motor cars, and at the present moment the subsidies amount to nearly six million francs annually for 119 services. A great many other lines are running without State aid owing to the refusal of the proprietors to accept the conditions imposed, requiring that the vehicles should make a double journey each day and that the service should be completed with a 2-ton lorry. It is now proposed to modify the conditions, and a Bill is being introduced whereby the amount of subsidy will be adjusted to the character of the service. In the preamble to the Bill reference is made to the tendency to abandon local railways where the traffic is not sufficient to cover working expenses, and it is urged that these lines should be made the most of with the aid of petrol rail cars, which could be run much more cheaply and are more adapatable to light traffic. As much as possible should be made of the local lines so as to relieve the roads, and the motor car services should be regarded merely as an extension of the railways and for reaching the most out-of-the-way villages.

### Well Boring.

The water supply in the department of the Somme is seriously occupying the attention of the Ponts et Chaussées, the engineers of which are engaged in extensive well sinking for distributing water to the various communes. The war devastation deprived the department of practically the whole of its supplies, and the British Army carried out valuable works, which were afterwards taken over by the State; but the lack of water was particularly felt during last year's drought, when a large number of communes had doled out to them water brought from considerable distances. The department has been divided into a number of sectors in which wells are sunk and the water raised to tanks by electrically driven pumps. In some parts the bores reached salt water at a depth of 100 m., which appears to exist over a wide area from the sea.

# British Patent Specifications.

*When an invention is communicated from abroad the name and address of the communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

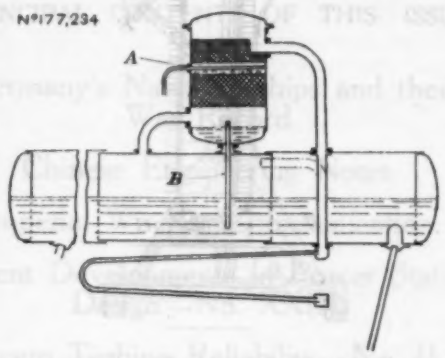
*Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton buildings, Chancery-lane, W.C., at 1s. each.*

*The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.*

## TURBINE MACHINERY.

177,234. December 20th, 1920.—TREATING STEAM TO REDUCE CORROSION, R. W. Bailey, 23, Stockport-road, Altrincham, Chester, and the Metropolitan-Vickers Electrical Company, Limited, 4, Central-buildings, Westminster.

IN order to eliminate the corrosive constituents of steam used in steam turbines, which would otherwise attack the blading, the inventors pass it through a chamber filled with metal that is at least equally liable to attack as is that of the blading. This

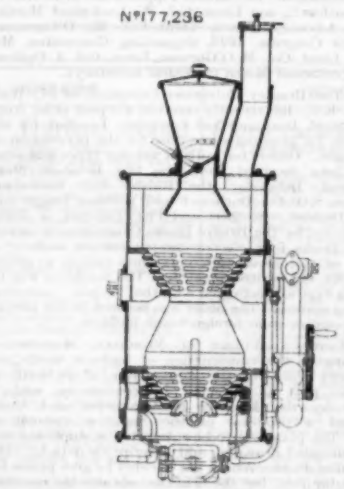



chamber is shown mounted above the drum of a water-tube boiler and between the drum and the superheater. The active material in the chamber is kept moist by a spray of water A, while the drainage runs back to the boiler by the pipe B.—*March 20th*, 1922.

## GAS PRODUCERS.

177,236. December 20th, 1920.—GAS PRODUCERS FOR VEHICLES, T. H. Parker, 18, Gainsborough Mansions, West Kensington, London, W. 14.

In this producer there are two grates, one above the other, as shown. A coil of pipe surrounds the lower grate for generating steam, which is injected below the upper grate. The lower

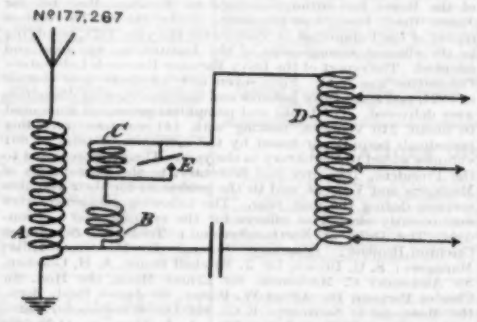



grate is provided with a hemispherical clinker cutter which can be rotated from the outside for breaking up the clinker.—*March 20th*, 1922.

## WIRELESS TELEGRAPHY.

177,267. December 24th, 1920.—IMPROVEMENTS IN WIRELESS TRANSMITTING APPARATUS, *Marconi's Wireless Telegraph Company, Limited, of Marconi House, Strand, W.C. 2.*

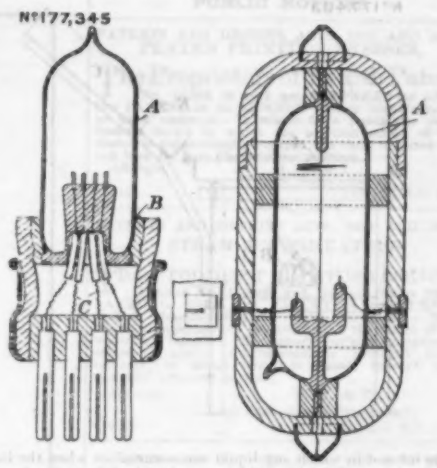
The aerial A is coupled to two coils B and C. When these coils are in circuit they are in opposition to one another and the




current in the aerial is practically nil. The coils form part of an oscillatory circuit D, in which oscillations can be set up by, say, a valve generator. When the contacts of the signalling key E are closed the coil C is short-circuited and the full energy is passed to the aerial by the coil B. With this arrangement it is possible to use an ordinary light relay as the signalling key, and a great increase in the speed of transmission can be obtained. The receiving station can also make full use of syntonisation and successfully employ mechanical recording apparatus.—*March 24th*, 1922.

177,345. February 12th, 1921.—IMPROVEMENTS IN ELECTRON DISCHARGE DEVICES, The General Electric Company, of 67, Queen Victoria-street, E.C. 4, and Albert Charles Bartlett, of the General Electric Company, Brook Green, Hammersmith.

It is well known that the efficiency of electron discharge devices such as thermionic valves is liable to be impaired by noise due to vibration of parts of the electrodes or supports within the valve, and the object of the present invention is to overcome this trouble. In the case of the arrangement shown on the left, the glass envelope A of the valve is mounted in a

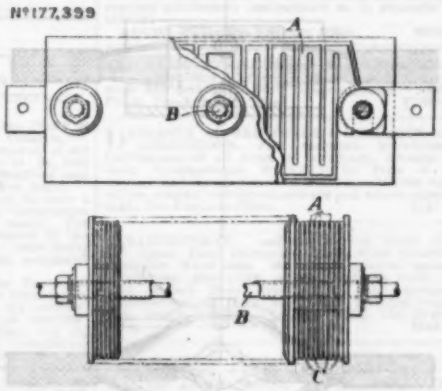



rubber holder B which reduces the mechanical vibrations transmitted to the envelope from its supports. Connections between the leading-in wires to the valve electrodes and the contact pins is established by means of thin wires C, which may be passed through a piece of rubber tubing. In the case of the arrangement shown on the right the valve A is enclosed in a case or holder of ebonite or similar material, and the valve is supported by rubber pads or rings.—*March 30th*, 1922.

## SWITCHGEAR.

177,399. March 22nd, 1921.—IMPROVEMENTS IN RHEOSTATS, Noel George Langrish, of 337, Moss-lane, East Manchester, and the Metropolitan-Vickers Electrical Company, of 4, Central-buildings, Westminster.

In one method of carrying out this invention the rheostat is composed of a number of resistance grids A, which are made of sheet metal stampings and are supported on rods B insulated with mica. The grids are separated from one another by plates C of

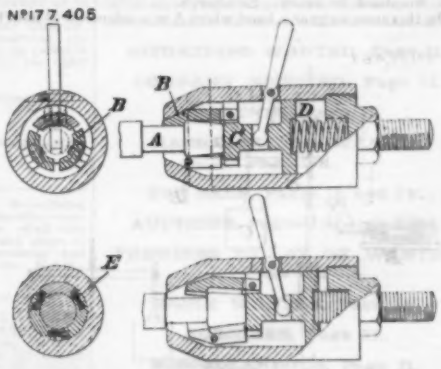



asbestos millboard or other suitable insulating material or pairs of insulating sheets with a metal plate interposed between each pair, the whole being clamped together by metal end plates and the usual nuts and washers. With this form of construction the thermal capacity of the rheostat is considerably increased for short runs and the necessary rigidity is imparted to the grids.—*March 30th*, 1922.

## MACHINE TOOLS AND SHOP APPLIANCES.

177,405. March 29th, 1921.—A CHUCK FOR BROACHES, W. H. Liddiard, Field-terrace, Rodborough-hill, Stroud.

In this chuck the broach A is held by the jaws B B gripping



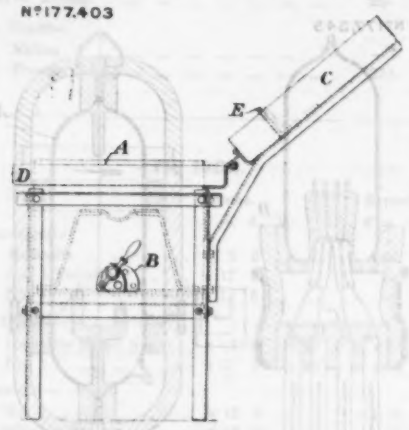

under its head and being forced together by the tapered nose of the chuck. The jaws are attached to a spider C and a hand lever is provided for withdrawing them to release the broach. A

spring D pushes the jaws into engagement with the broach, while small springs E E hold the jaws apart to facilitate removing the broach. It will be noticed that the device is self-centring and that the pull on the broach increases the grip.—*March 30th*, 1922.

177,403. March 29th, 1921.—IMPROVEMENTS IN DIPPING TANKS FOR COATING ELECTRICAL APPARATUS AND MACHINERY, Harold Dalrymple Symons, of 196, Deansgate, Manchester.

THE dipping tank described in this specification comprises a varnish or similar receptacle A with a drain cock B at the bottom. When the lid C is closed its edges enter a sealing channel D, which may be filled with heavy oil or sand. The receptacle is mounted on a portable frame or stand. The inside of the lid is provided with a projecting lip E, which forms a channel across

N°177,403



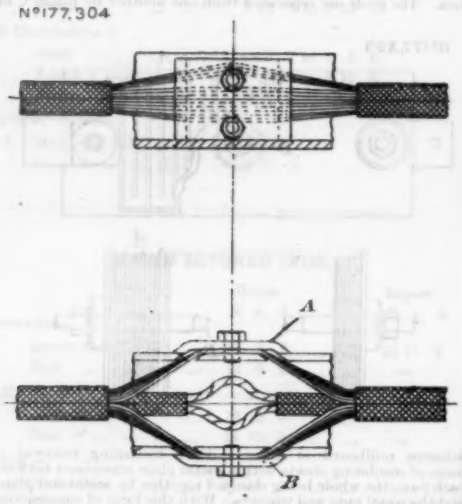

the lid and in which any liquid can accumulate when the lid is opened, but the liquid will be returned to the receptacle when the lid is closed. When the lid is open an armature or other pieces of electrical machinery or apparatus can be suspended, after it has been dipped, over the lid in order that the surplus varnish may drip on to the lid and be returned to the receptacle after the lid has been closed. Brackets are provided to carry armatures and other electrical parts that have to be impregnated.—*March 30th*, 1922.

## TRANSMISSION OF POWER.

177,304. January 18th, 1921.—IMPROVEMENTS IN OR RELATING TO ELECTRIC JUNCTION BOXES, Frank Cox, 22, Mayfield-road, Carlton, Notts.

According to one method of carrying out this invention, the base of the junction box has two vertical slots at each side, each allowing half of the armouring wires to be passed outside the box. Metal plates A and B at each side of the box are attached

N°177,304



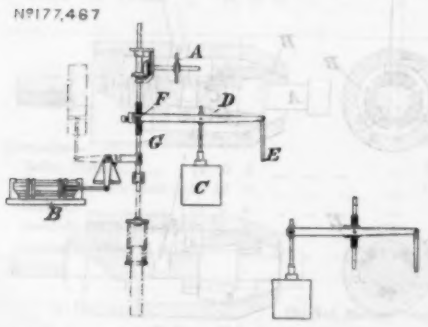

by screws so as to cover the slots and grip the armouring wires. The object of the invention is to avoid cutting the armouring and the conductors contained in the cable. An alternative method of carrying out the invention is also described.—*March 30th*, 1922.

## SHIPS AND BOATS.

177,467. September 13th, 1921.—STEERING GEAR, W. Wallace, Rosebank Ironworks, Edinburgh.

In this steering gear a hand wheel A or a telemotor B may be

N°177,467



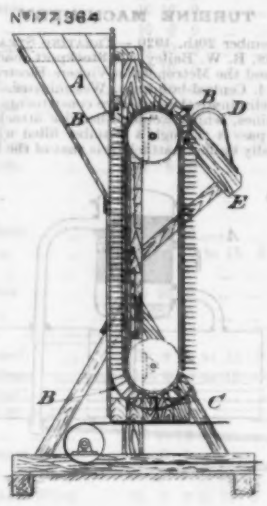

used to operate the control of the steering engine C. In either case the control is moved by the floating lever D, one end of which is connected with the rudder *viâ* E. At the other end of the lever there is a nut F, which is held against rotation. Turning the hand wheel A rotates the shaft G and moves the floating lever through the nut F, while the telemotor B operates the lever by moving the shaft G bodily endways. Alternative positions for the telemotor are shown in dotted lines.—*March 30th*, 1922.

## MISCELLANEOUS.

177,364. February 24th, 1921.—DECORTICATING MACHINES, W. T. Bell, Robey and Co., Limited, Lincoln, and G. Taylor.

This machine is intended to treat the refuse from decorticating machines and comprises a band of slats furnished with spikes as shown. The refuse is fed in at the hopper A and is dragged

N°177,364




down by the spikes, which engage the fibre. Water is supplied at B B B and washes the treated refuse away through a perforated plate C on to a conveyor below. The fibre is cleaned off the spikes by a comb D and led away by a shoot E.—*March 30th*, 1922.

ROYAL AERONAUTICAL SOCIETY.—The following representatives of the Royal Aeronautical Society on other bodies have been nominated for the year ending April, 1923:—Conjoint Board of Scientific Societies, Lieut.-Col. M. O'Gorman; Aeronautical Research Committee, Lieut.-Col. A. Ogilvie; Advisory Committee on Aeronautical Education, Professor C. F. Jenkin; British Engineering Standards Association Aircraft Committee, Lieut.-Col. M. O'Gorman; B.E.S.A. Aircraft Sub-Committee No. 1 (Nomenclature), Professor L. Bairstow, Lieut.-Col. M. O'Gorman, Dr. Sutton Pippard, Mr. J. D. North, Major R. V. Southwell, and Lieut.-Col. W. Lockwood Marsh; Civil Aviation Advisory Board, Lieut.-Col. M. O'Gorman; International Air Congress, 1923, Organising Committee, Mr. Griffith Brewer, Lieut.-Col. M. O'Gorman, Lieut.-Col. A. Ogilvie, Lieut.-Col. W. Lockwood Marsh (technical secretary).

CONTRACTS.—The Bradley Pulveriser Company, of 37, Walbrook, London, E.C., has recently received a repeat order from the Ebbw Vale Steel, Iron and Coal Company, Limited, for six 30in. Griffin mills for grinding stone dust for the prevention of explosions in mines. Orders for mills of various types and sizes have recently been received from the Old Delabole Slate Quarries, Limited, Delabole; the Raisby Hill Limestone Quarries, Coxhoe, S.O. Co. Durham; and William Briggs and Sons, Limited, Dundee.—Stothert and Pitt, Limited, of Bath, have been instructed by the Bristol Docks Committee to install at Avonmouth Docks four electric gantry cranes, each of a lifting capacity of 1½ tons at 45ft. maximum radius, to travel on rails spaced 8ft. 6in. centre to centre. The machines will be of the four-motor type and arranged with the "Toplis" patented horizontal luffing system. The order was secured in the face of the severe competition from foreign crane builders.

PROPOSED HARBOUR WORKS AT FUNCHAL, MADEIRA.—Firms specialising in the construction of harbour works are invited to present plans for the construction of an artificial harbour at the port of Funchal in conformity with a plan approved by the Minister of Commerce and Communications and a proposal of the Superior Council of Public Works. The plans are to be submitted in duplicate and are to include detailed drawings and descriptive details. The Superior Council of Public Works has decided to give prizes for the best plans submitted, but the firm that obtains the contract will not receive a prize. Preference will be given to the plans which comply with the following conditions:—(1) The shortest time taken in the construction of the works; (2) the least number of years taken providing a workable harbour; and (3) the lowest price per ton for loading and unloading cargo. Firms will be given every facility for examining all documents relating to the construction at the Secretary's office of the Junta Autonoma to assist them in drawing up their plans. They will also be permitted to modify the general plan as regards disposition and dimensions, if the modifications are justified and are in harmony with the general plan as approved. Further information can be obtained from the Secretary, Junta Autonoma das Obras do Porto, Funchal.

ROYAL INSTITUTION.—The annual meeting of the members of the Royal Institution was held on Monday, May 1st, Sir James Reid, Bart., vice-president, in the chair. The annual report of the Committee of Visitors for the year 1921, testifying to the efficient management of the Institution, was read and adopted. The report of the Davy Faraday Research Laboratory Committee was read. Fifty-seven new members were elected in 1921, and sixty-three lectures and nineteen evening discourses were delivered. The books and pamphlets presented amounted to about 210 volumes, making with 441 volumes (including periodicals bound) purchased by the managers, a total of 651 volumes added to the library in the year. Thanks were voted to the President, Treasurer and Secretary, to the Committees of Managers and Visitors, and to the professors for their valuable services during the past year. The following gentlemen were unanimously elected as officers for the ensuing year:—President, The Duke of Northumberland; Treasurer, Sir James Crichton-Browne; Secretary, Colonel E. H. Grove-Hills; Managers: S. G. Brown, Dr. J. Mitchell Bruce, A. H. Goschen, Sir Alexander C. Mackenzie, Sir Ernest Moon, the Hon. Sir Charles Parsons, Dr. Alfred W. Porter, Sir James Reid, Bart., the Marquess of Salisbury, K.G., Sir David Salomons, Bart., Joseph Shaw, William Stone, Sir J. J. Thomson, O.M., Sir Almroth Wright, the Right Hon. Lord Justice Younger; Visitors: J. H. Batty, Dr. W. A. Bone, Alfred Carpmael, Dr. E Clarke, Sigismund Goetze, G. H. Griffin, Dr. J. H. Leeson, Sir Oliver Lodge, P. A. Molteno, Sir Malcolm Morris, Richard Pearce, H. M. Ross, Sidney Skinner, T. H. Sowerby, William A. Tait.

# Forthcoming Engagements.

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to take that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

IRON AND STEEL INSTITUTE.—Institution of Civil Engineers, Great George-street, S.W. 1. Annual meeting.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, St. James's Park, S.W. 1. Informal meeting. Subject, "Failures." 7 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. "Biological Studies in Madeira," by Mr. Michael Grabham, M.D. 9 p.m.

THE JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, Westminster, S.W. 1. Lecturette, "Gold Casting Under Steam Pressure," by Mr. E. N. Ching. 8 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "Imperial Wireless Communication," by Professor W. H. Eccles. 4.30 p.m.

SATURDAY, MAY 6TH.

ROYAL AERONAUTICAL SOCIETY.—Visit to the De Havilland Aircraft Works, Edgware. Meet at works, 10 a.m.

THE ASSOCIATION OF ENGINEERS-IN-CHARGE.—St. Bride's Institute, Bride-lane, E.C. 4. Discussion, "Uniflow *versus* Multiple-expansion Steam Engines." 7.30 p.m.

LONDON ASSOCIATION OF FOREMEN ENGINEERS.—Cannon Street Hotel. Sixty-ninth anniversary festival. 6 p.m.

INSTITUTION OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—College of Technology, Manchester. Annual meeting. Paper, "The Manufacture of Coke for Industrial Purposes," by Mr. A. D. Young. 4 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Lecture, "Industrial Relationships (II.). The Problem of Structure," by Professor D. H. MacGregor. 3 p.m.

MONDAY, MAY 8TH.

THE INSTITUTION OF CIVIL ENGINEERS: YORKSHIRE ASSOCIATION.—Technical College, Bradford. Joint meeting with the Bradford Engineering Society. Lecture, "Brakes for Tramway and Road Vehicles" (lantern), by Mr. J. W. Dawson. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—The College, Loughborough. Meeting of the Loughborough Graduates. Paper, "Lubricants." 7 p.m.

TUESDAY, MAY 9TH.

INSTITUTION OF BRITISH FOUNDRYMEN: BURNLEY SECTION.—Technical College, Ormerod-road, Burnley. Annual meeting. Discussion, "The Burning of Castings." 7.30 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Royal Society of Arts, John-street, Adelphi, W.C. 2. Paper, "Kukkersite, the Oil Shale of Esthonia," by Mr. E. H. Cunningham Craig. 5.30 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, 5, John Dalton-street, Manchester. Presidential address, by Mr. Sydney A. Smith. Papers for discussion:—"Heating of the Goaf and Steps Taken in Conjunction therewith at Chanters Colliery," by Mr. Cecil Newton; "The Results of a Microscopical Examination of Batt and other Kindred Substances in Coal Seams," by Mr. James Lomax. 4 p.m.

WEDNESDAY, MAY 10TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Paper: "Automobile Calculations; Practical Methods for the Designer," by Mr. James Watt. 8 p.m.

SOCIETY OF TECHNICAL ENGINEERS: SOUTH-EASTERN DISTRICT.—Institution of Electrical Engineers, Savoy-place, W.C. 2. Lecture, "An Engineering Tour in India," by Dr. J. F. Crowley. 7 p.m.

THE JUNIOR INSTITUTION OF ENGINEERS.—Caxton Hall, Westminster, S.W. 1. Paper, "Notes on Hardness," by Mr. R. K. Innes. 8 p.m.

ENGINEERING GOLFING SOCIETY.—Spring meeting on the course of the West Hill Golf Club, Brookwood, Surrey. 10 a.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, W.C. 2. "The Design of Repeating Patterns for Decorative Work," by Major P. A. MacMahon. 8 p.m.

THURSDAY, MAY 11TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—College of Technology, Manchester. Lecture, "Tanks and Chain-track Artillery," by Mr. L. A. Legros. 7 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, Piccadilly, W. 1. Lecture, "Plant Sensitiveness." (I.), by Professor F. Keeble. 3 p.m.

FRIDAY, MAY 12TH.

JUNIOR INSTITUTION OF ENGINEERS.—Institution of Mechanical Engineers, Storey's-gate, Westminster, S.W. 1. Lecture, "Tanks and Chain Track Artillery," by Mr. L. A. Legros. 7.30 p.m.

WEST BROMWICH ENGINEERING SOCIETY.—Technical School, West Bromwich. Paper, "Fuels," by Mr. S. Lamb. 7.30 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Holborn Borough Council Offices (opposite British Museum Tube Station). Metropolitan District meeting to consider the question of the revision of the areas allotted to the different Districts of the Institution. 4 p.m.

SATURDAY, MAY 13TH.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Lecture, "The Disappearing Gap between the X-ray and Ultra-violet Spectra," by Mr. O. W. Richardson, D.Sc. 3 p.m.

WEDNESDAY, MAY 17TH.

INSTITUTION OF AUTOMOBILE ENGINEERS: NORTH OF ENGLAND CENTRE.—Y.M.C.A. Hall, Albion-place, Albion-street, Leeds. Paper: "Experiments on Cams and Poppet Valves," by Professor G. F. Scholes. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS.—Chamber of Commerce, New-street, Birmingham. Meeting of Birmingham Graduates. Paper, "Progress," by Mr. A. O. Marshall. 7.30 p.m.

THURSDAY, MAY 18TH.

INSTITUTION OF AUTOMOBILE ENGINEERS.—28, Victoria-street, S.W. 1. Meeting of the London Graduates. Paper, "Electrical Equipment," by Messrs. P. H. Hardy and L. B. Harris. 8 p.m.